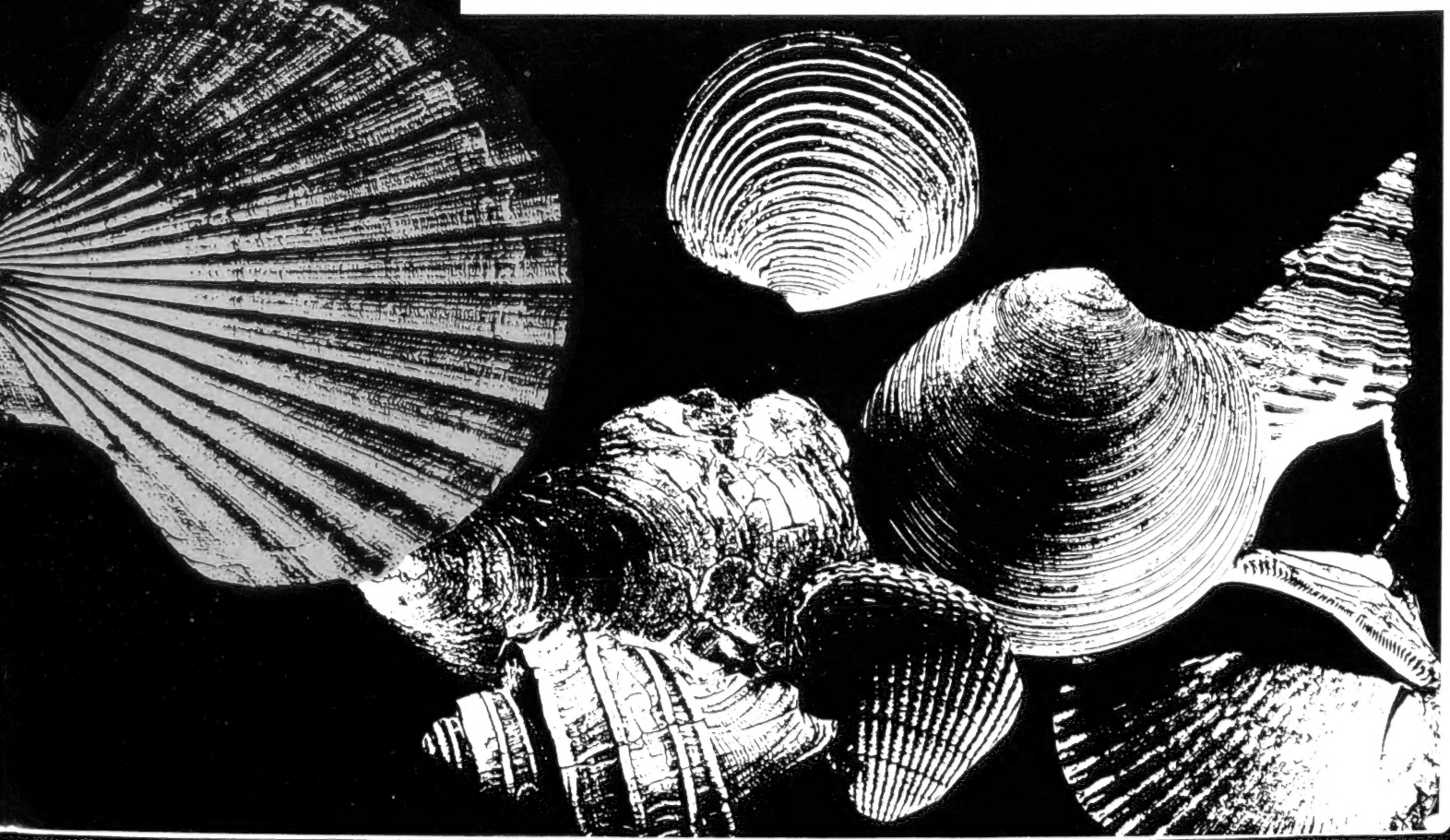
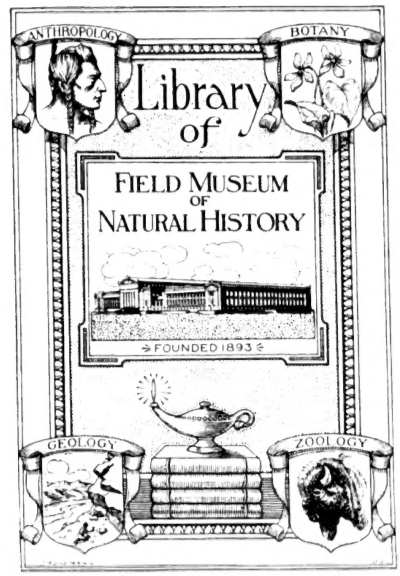
Molluscan Biostratigraphy of the Miocene, Middle Atlantic Coastal Plain of North America

Lauck W. Ward

Virginia Museum of Natural History Memoir Number 2





MOLLUSCAN BIOSTRATIGRAPHY OF THE MIOCENE, MIDDLE ATLANTIC COASTAL PLAIN OF NORTH AMERICA

. . . he that is searching for rare and
remote things, will neglect those that
are obvious and familiar . . .

— Samuel Johnson, 1755

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MOLLUSCAN BIOSTRATIGRAPHY OF THE MIOCENE, MIDDLE ATLANTIC COASTAL PLAIN OF NORTH AMERICA

by Lauck W. Ward

ABSTRACT

In spite of over one hundred years of attention to the Miocene geology of the Coastal Plain of the middle Atlantic states of North America, the area still lacks a comprehensive biostratigraphic framework. Biostratigraphic concepts are reviewed and a zonation based on mollusks is proposed that covers the relatively complete Miocene section in Maryland, Virginia, and North Carolina. A series of eight interval-zones are described, based on first-occurrence data of stratigraphically important mollusks. The upper limit of each zone is defined as the base of each succeeding zone so that the entire time sequence of the Miocene is represented. The molluscan assemblages contained in each of these biozones are discussed and figured, and type sections for these zones are designated and described. Because of the relatively complete nature of the stratigraphic record of the Miocene in this area, it is suggested that it might serve as a worldwide standard for that epoch. The mollusks used in the study are treated systematically, and their nomenclatural histories as well as their geographic and stratigraphic ranges discussed. Thirty-five new species or subspecies and seven new genera are named and described.

INTRODUCTION

The strata exposed along the Chesapeake Bay in Maryland and related beds in Tidewater Virginia and coastal North Carolina have received much attention since the early nineteenth century from such well-known workers as Thomas Say, T. A. Conrad, W. B. Rogers, H. C. Lea, Charles Lyell, W. B. Clark, W. H. Dall, L. C. Glenn, G. C. Martin, and others. Because of the excellent and widespread exposures of the beds in this region and the fine preservation of their contained fossils, thousands of molluscan taxa have been identified and described. In spite of this attention and the relative completeness of the fossil record, little effort was made by these early workers to subdivide the units either chronostratigraphically (except to series designation) or biostratigraphically.

Isaac Lea (1833), following the work of Lyell in England, divided the North American Tertiary into the Eocene, Miocene, and Pliocene and placed beds in New Jersey, Maryland, and Virginia, now thought to be Miocene, in the "Older Pliocene." Conrad (1832), however, followed the terminology of Conybeare and Phillips (1822) and subdivided the Tertiary into the Upper Marine (Miocene), Middle Tertiary (Eocene), and Lower Tertiary. Later works by Conrad (1845, 1861) referred to strata, now considered to be both Miocene and Pliocene, as Miocene. Dana (1863), realizing the difficulty of applying the Lyellian terms Eocene, Miocene, and Pliocene to North American strata, suggested a new classification. Citing the impracticability of a system of percentages of extant taxa to classify strata, Dana suggested calling the older beds the "Yorktown epoch" and the younger beds the "Sumpter epoch." Later, Heilprin (1882) proposed the following classification for beds he included in the Miocene:

1. Carolinian (Upper Atlantic Miocene)—Deposits of South and North Carolina ("Sumpter" epoch of Dana).
2. Virginian (Middle Atlantic Miocene)—Deposits of Virginia, and of the "Newer" group in Maryland ("Yorktown" epoch, in part, of Dana).
3. Marylandian (Lower Atlantic Miocene)—Deposits of the "Older" group of Maryland, and possibly the lower Miocene beds of Virginia ("Yorktown" epoch, in part, of Dana).

In this classification, Heilprin was obviously influenced by d'Orbigny's system of European stages, using local geographic names, referring to localities where the beds could be found, and including lists of fossil taxa that were found in each unit. Unfortunately, the state of the art at that time did not allow a refined splitting of the various beds involved. This resulted in

the lumping of beds of both Miocene and Pliocene age. In short, Heilprin's system was an oversimplification of a much more complicated series of beds. Dall and Harris (1892) ignored Heilprin's system, used the terms Miocene and Pliocene, and exhaustively described all beds that they assigned to those series. Dall (1898c) later prepared a correlation chart in which he assigned the important North American beds to epochs and stages and correlated them with their foreign analogues. However, no names were used for the Miocene beds on the Atlantic coast. Further, Dall's belief that the Aquitanian Stage belonged in the Oligocene caused him to assign beds now considered to be lower Miocene to that series. Olsson (1917) used the term *stage* to describe a newly recognized unit, the Murfreesboro, in Virginia and North Carolina, but it is evident that he used the term in a lithic sense. Fortunately, the name was preoccupied, as Olsson included beds of several ages in his new unit. Later, Malkin (1953) tentatively designated informal substages in the "Miocene" sediments of Maryland and Virginia. Again, these units were based on the previously established formations and their names were derived from those of the formations. These substages were subdivided into six faunizones based on ostracodes. Later work has shown these zones to be based on previously established lithostratigraphic subdivisions and to be of little value beyond that degree of refinement.

Blackwelder and Ward (1976) informally proposed a system of molluscan "range zones" for the Miocene and Pliocene beds in Maryland and Virginia. Refinement of the lithostratigraphic succession and molluscan biostratigraphy has led to the abandonment of that zonation. Blackwelder (1981) established six molluscan biozones in the Pliocene to Holocene deposits of the middle Atlantic Coastal Plain and proposed that the beds be divided into four stages and four substages. This molluscan biozonation extended to the basal beds of the Yorktown Formation (lower Pliocene) but did not include any beds older than Pliocene.

A new molluscan biozonation of the Miocene beds in the middle Atlantic Coastal Plain is herein proposed. The faunal zones are established, based on the molluscan lineages whose stratigraphic and geographic ranges are well known.

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PALEOGEOGRAPHIC SETTING

The Atlantic Coastal Plain margin of the United States is scalloped by a series of basins, or depocenters, and intervening high areas, or arches, on which there was considerably less sedimentation (figure 1). Data for this biostratigraphic study was obtained principally from the Salisbury Embayment. This was supplemented with data from the Albemarle Embayment, particularly in the lower Miocene sections. Ward (1984) and Ward and Strickland (1985) described the relatively complete series of Miocene beds in these basins. It is felt that the excellent stratigraphic record (figure 2) in this middle Atlantic area is due to intermittent structural movements and subsidence which resulted in sediment accumulation.

Both the Salisbury and Albemarle Embayments were the site of sedimentation in a shallow-shelf open marine setting. During the early and middle Miocene the Salisbury Embayment was a partially protected, lagoonal environment with the principal seaward opening to the northeast. The sediment source was clearly to the northeast, and detrital material becomes progressively finer toward the innerbay settings and shoreward to the southwest. In these quieter settings, silts and clays were deposited, and considerable thicknesses of diatoms accumulated. The fine sediments and diatom concentrations resulted in soft bottom conditions that were not suitable for most molluscan habitation. Molluscan assemblages are greatest, in terms of numbers of individuals and diversity, in areas where the influx of sand and silt mixed to form suitable substrates. These areas are

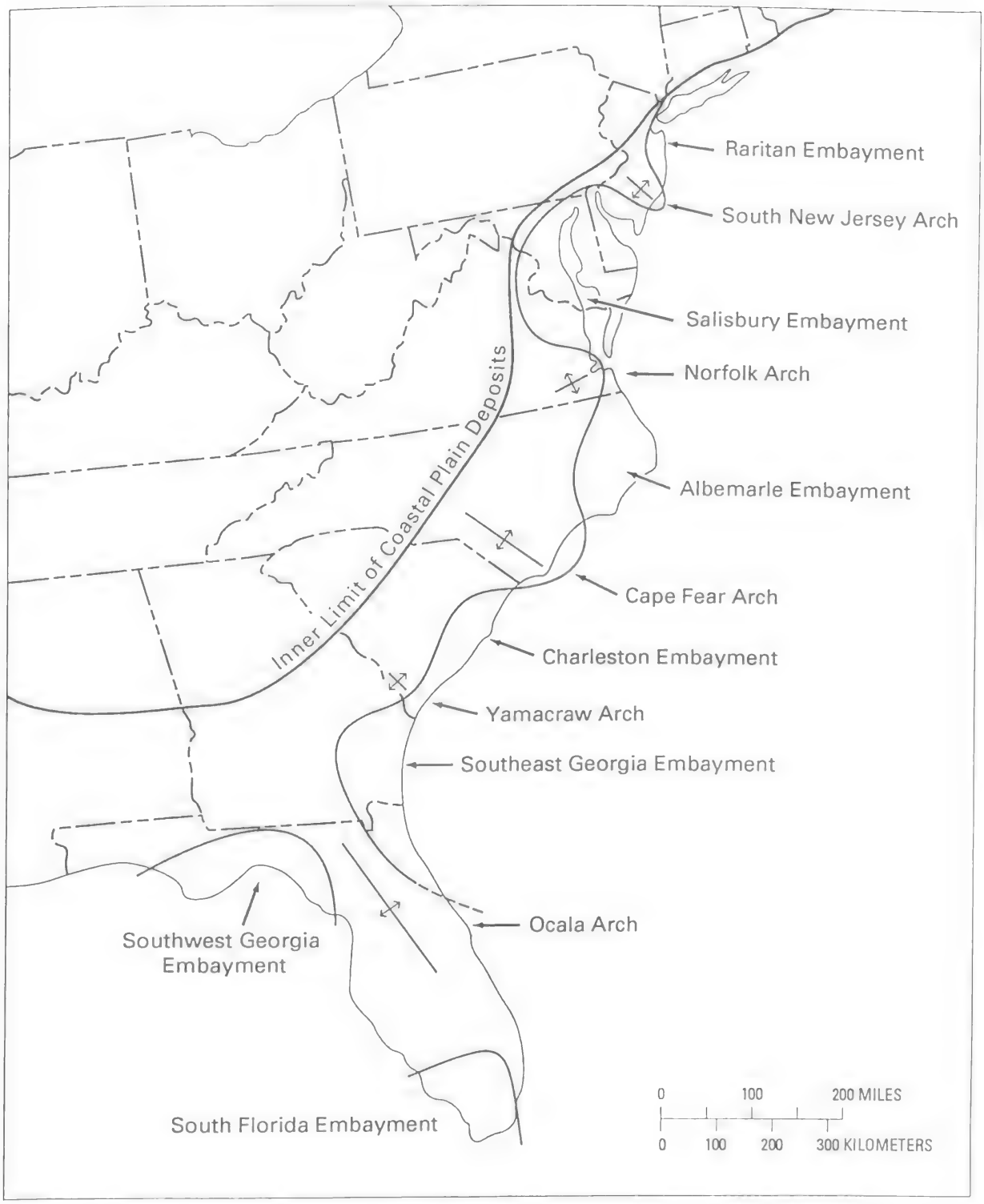
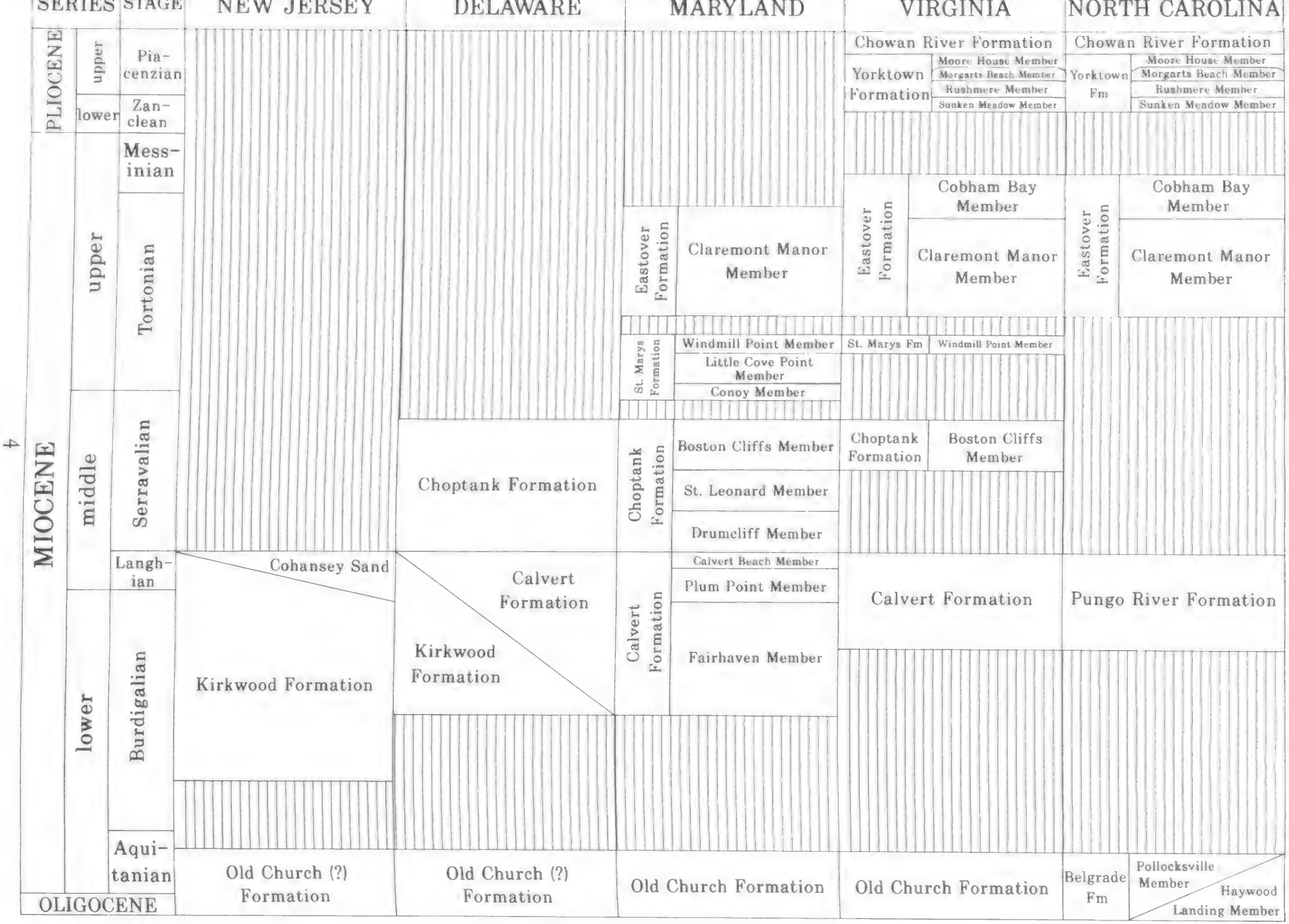


Figure 1.—Major structural features of the Atlantic Coastal Plain from New York to Florida. Dashed lines indicate area where boundary data are lacking (after Ward and Strickland, 1985). Outlined embayments are major sites of sediment accumulation or depocenters.


SERIES
STAGE
NEW JERSEY
DELAWARE
MARYLAND
VIRGINIA
NORTH CAROLINA
PLIOCENE
upper
lower
Pia-cenzian
Zan-clean
MIOCENE
upper
middle
lower
Mess-inian
Tortonian
Serravalian
Langh-ian
Burdigalian
Aqui-tanian
OLIGOCENE
Chowan River Formation
Chowan River Formation
Yorktown Formation
Moore House Member
Morgarts Beach Member
Rushmere Member
Sunken Meadow Member
Yorktown Fm
Moore House Member
Morgarts Beach Member
Rushmere Member
Sunken Meadow Member
Eastover Formation
Cobham Bay Member
Claremont Manor Member
Eastover Formation
Cobham Bay Member
Claremont Manor Member
Eastover Formation
Claremont Manor Member
St. Marys Formation
Windmill Point Member
Little Cove Point Member
Conoy Member
St. Marys Fm
Windmill Point Member
Choptank Formation
Boston Cliffs Member
St. Leonard Member
Drumcliff Member
Choptank Formation
Boston Cliffs Member
Choptank Formation
Cohansey Sand
Calvert Formation
Kirkwood Formation
Kirkwood Formation
Calvert Beach Member
Plum Point Member
Fairhaven Member
Calvert Formation
Calvert Formation
Pungo River Formation
Old Church (?) Formation
Old Church (?) Formation
Old Church Formation
Old Church Formation
Belgrade Fm
Pollocksville Member
Haywood Landing Member

well seaward in the embayment and towards the centers of the various basins where the bottom was well-oxygenated and swept by currents. Nearshore environments associated with higher energy conditions may have been areas favorable to molluscan exploitation, but these areas are not ordinarily preserved as the succeeding transgressive sea tends to bevel and remove those beds.

Several of the beds in the Miocene sequence are sandy only in their basal, transgressive portion and grade into silts and silty clays as the water becomes deeper. In these cases the basal sandy portions contain abundant molluscan concentrations, whereas the upper, finer sediments have a few specialized taxa.

To summarize, the Salisbury and, to a lesser extent, the Albemarle Embayments were protected, lagoonal environments of normal marine salinity that contained an open-shelf, diverse molluscan assemblage seaward to the northeast and were the site of the accumulation of finer sediments and diatoms upbay and to the southwest.

DEPOSITIONAL HISTORY

The Miocene lithostratigraphic units involved in the present study are the Belgrade, Old Church, Calvert, Choptank, St. Marys, and Eastover Formations. Ward (1985*a*) recognized a series of depositional events (I-XIX) or allostratigraphic units in the Miocene and Pliocene of Maryland, Virginia, and North Carolina (figure 3) that are represented within those formations. The depositional events (DE) associated with these beds are numbered I to XV, from oldest to youngest. All beds, lithofacies, and biofacies that are considered to be associated with a unique, transgressive, depositional event are included under a single roman numeral. The purpose of such a system is to remove the sometimes artificial system of nomenclature based solely on lithology and recognize the proper sequence of Miocene beds and the natural breaks or unconformities within that sequence. As can be seen in figure 3, the molluscan zonation, depositional event zonation, and lithostratigraphic framework do not necessarily coincide. For example, the Calvert Formation comprises seven depositional events, involving three molluscan zones.

The sequence of depositional events began with sedimentation in the middle Atlantic Coastal Plain during the late Oligocene or early Miocene resulting from a small transgressive pulse. This overlap resulted in a series of thin beds in Virginia (Old Church Formation) and North Carolina (Belgrade Formation). Beds associated with this depositional event (DE-I) are preserved only in small geographic areas. The molluscan assemblages in the Belgrade are tropical in nature while the Old Church fauna is decidedly temperate. Three distinct depositional events can be discerned within the Miocene beds that overlie the Old Church. Unconformities separate the three, and each has a unique molluscan assemblage. The first onlap resulted in the deposition of a series of silty sands (DE-II), which amount to several hundred feet in New Jersey (J. P. Owens personal communication, 1986) but thin to only several feet in Calvert and Prince Georges County, Md. The silty sands, because of their weathered state, lack diagnostic fossils for biostratigraphic zonation. The unit, called "Zone" 1 by Shattuck (1904), was tentatively correlated with the Old Church Formation by Ward (1984). "Zone" 1 is now believed to be a distinct unit, younger than the Old Church, and was assigned to Depositional Event II by Ward (1985*a*).

The northeastern portion of the Salisbury Embayment was again the site of transgression and sedimentation during two onlap events termed DE-III and DE-IV, the beds of which are both included in the Fairhaven Member. Both resulted in the deposition of considerable thicknesses of very diatomaceous silt and fine sand. A diastem of considerable time significance is indicated by the unconformity between the two units.

The Plum Point Marl Member of the Calvert Formation overlies the Fairhaven and contains three distinct depositional units, termed DE-V, DE-VI, and DE-VII, that represent three marine pulses punctuated by brief diastems. The locus of deposition during those events had shifted somewhat southward to the northern part of Calvert County, Md. The units are all silty sands, especially in the basal transgressive portion. Mollusks are abundant in the sandier facies.

The Plum Point beds are followed by the Calvert Beach Member. Beds associated with this event (DE-VIII) extend southeastward as far as the James River in Virginia and are present in the Pungo River Formation in the Salisbury Embayment of North Carolina. The wide distribution of the Calvert Beach would indicate a significant high stand that coincided with a structural downwarping of the middle Atlantic Coastal Plain basins.

A significant basinal shift within the Salisbury Em-

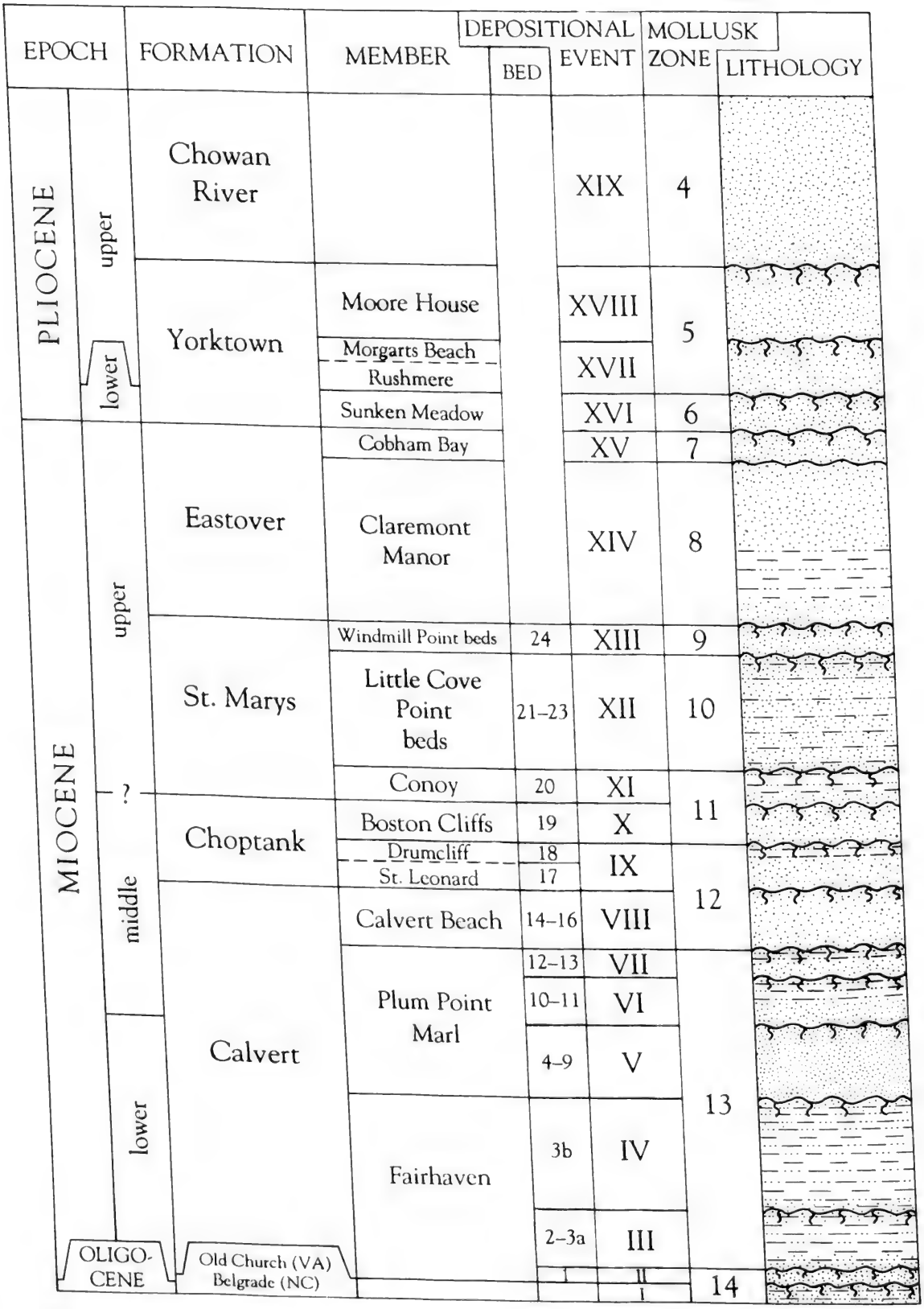


Figure 3.—Composite stratigraphic section showing the formations, members, Shattuck's (1904) "zones," mollusk zones, and depositional events. Lithologies of the units and the unconformities between them are shown graphically.

bayment occurred in the middle middle Miocene. At that time the basin was briefly uplifted and eroded. As the area again subsided, the resulting transgression followed closely the channeled upper surface of the Calvert Beach Member. Deposition took place principally in channeled areas where very shelly, clean, fine sands accumulated. This depositional event (DE-IX) is represented by the Drumcliff and St. Leonard Members of the Choptank Formation. The basin where beds associated with this transgression occur is restricted to southern Maryland and the Eastern Shore of Maryland. Another small-scale structural shift and brief hiatus marked the end of DE-IX and preceded the deposition of sediments included in the Boston Cliffs Member.

Onlap and sedimentation resumed in the upper middle Miocene, resulting in a widespread transgression termed DE-X. Beds in Maryland and Virginia associated with this event are called the Boston Cliffs Member of the Choptank and extend to the Fall Line from Fredericksburg to Richmond. Beds assigned to this unit range from shelly shelf sands to diatomaceous, silty clays in the updip, inner bay equivalents.

A general uplift in the late middle Miocene followed DE-X, and the basinal area again shifted to the south. Sedimentation resumed after a short hiatus, with the basin locus in southern Calvert County. Beds associated with this transgression (DE-XI) are called the Conoy Member of the St. Marys Formation (Ward, 1984). The Conoy Member is very restricted in its distribution, being found principally in the southern portion of Calvert County, Md. Sediments within the basin were of shallow, inner-bay origin and probably reflect a back-barrier environment.

A brief regression followed the Conoy depositional event (DE-XI), and the ensuing transgression was of slightly greater extent. Beds associated with the transgression, named the "Little Cove Point beds" of the St. Marys Formation (Ward, 1984) (DE-XII), are found mostly in southern Calvert County and eastern St. Marys County, Md. This distribution shows a basinal shift to the south into the area of St. Marys County, Maryland, in the late Miocene. Most of the beds associated with DE-XII, the Little Cove Point beds (Ward, 1984), reflect shallow, inner-bay conditions with the exception of several mollusk-rich, high-diversity, shell beds. Those beds suggest that several brief marine pulses resulted in more open shelf conditions in the embayment.

Following DE-XII the basin shifted dramatically southward in a relatively brief period of time during the late Miocene. The resulting locus of deposition following that shift and during the next transgression (DE-XIII) was approximately in the area of Lancaster County, Va. Beds associated with this onlap are called the "Windmill Point beds" of the St. Marys Formation (Ward, 1984). This depositional event marked the first time that the locus of deposition had shifted exclusively into Virginia. Molluscan assemblages associated with the Windmill Point beds and DE-XIII are rich, both in terms of abundance and diversity, and suggest open-shelf marine conditions.

A somewhat more lengthy hiatus followed DE-XIII, and the next episode of sedimentation occurred in the late Miocene. Beds associated with this transgression are the Claremont Manor Member of the Eastover Formation and are included in DE-XIV. The embayment at that time was more extensive than during DE-XIII and extended to the Fall Line from Fredericksburg to south of Petersburg, Va. The basin included the southeast portion of Maryland but was centered in Virginia. The transgression overlapped the Norfolk Arch into the Albemarle Embayment in North Carolina and extended southward as far as the Neuse River. This was the first record of sedimentation in the Albemarle Embayment since DE-VIII in the lower middle Miocene (Pungo River Formation). This basin, in spite of its size, contained a relatively non-diverse molluscan fauna, suggesting restricted inner-bay conditions. In the later stages of DE-XIV molluscan diversity increased as more open shelf conditions prevailed, as can be seen in the upper part of the Claremont Manor Member of the Eastover.

A very brief regression interrupted sedimentation during the late Miocene, but sedimentation resumed with another transgression that overlapped the Norfolk Arch and extended into the Albemarle Embayment. Deposits associated with this transgression (DE-XV) are included in the Cobham Bay Member of the Eastover Formation. These beds are generally thin, in some areas only centimeters thick, and they are thought to be the product of only a brief period of sedimentation or of erosion during the interval between the late Miocene and the late early Pliocene, a period for which there is no stratigraphic record. In any event, the resulting bed is thin, though widespread, and the molluscan assemblages are diverse and abundant. The basin conditions are interpreted as having been open marine, shallow shelf with normal salinities.

A large scale regression followed the Cobham Bay (DE-XV), and no sedimentation is known to have occurred in the area until the late early Pliocene and the deposition of the Sunken Meadow Member of the Yorktown Formation.

The Miocene, then, was a period of fluctuating sea levels and tectonic movement, which affected basin alignment and sedimentation. The result is a record of deposition marked by unconformities. These unconformities reflect sea-level low stands, basin realignment, and the hiatuses during which time these changes took place. The Miocene in the middle Atlantic states is recorded in fifteen clearly defined beds (I–XV), which are separated by unconformities of varying significance. During these depositional events, unique molluscan assemblages evolved, which make their correlation possible.

MOLLUSCAN PALEONTOLOGY

The molluscan biostratigraphy is based principally on several thousands of collections from Maryland, Virginia, and North Carolina made by the author. Also used were the upper Tertiary mollusk collections of the U.S. Geological Survey and the National Museum of Natural History. From these collections 145 species were selected, which represent some of the more common forms in the Miocene beds, and also include taxa with excellent stratigraphic records and rapid speciation rates. These species can be more confidently used for correlation than the "exotic" taxa, of which there are many, that appear only for short intervals. Exotic taxa are useful when studying whole assemblages or paleoenvironments but usually have little biostratigraphic value by themselves. Also studied were species present in large numbers, or of significant paleoecologic value.

A study based on the more common species would suggest little necessity for nomenclatural revision, but such was not the case. Of the 145 species, 35 are new species or subspecies, and 7 were determined to belong to new genera. Part of this problem was due to past use of European and Indo-Pacific generic names when they did not strictly apply. Many of the new specific names were needed to clarify the confusion over Say's (1824) taxa. This problem was discussed by Ward and Blackwelder (1975) and is further dealt with in the systematics section. Other species merely were not recognized by other authors or were lumped with existing taxa.

Principal collections available for the systematic study are housed at The Academy of Natural Sciences of Philadelphia (ANSP) and at the National Museum of Natural History (USNM), and include the types of Conrad, Morton, Wagner, Say, Isaac Lea, H. C. Lea, Heilprin, Dall, Gardner, Glenn, and Martin. Other types examined are those of Emmons in the Paleontological Research Institution (P.R.I.) and of Say in the British Museum (Natural History) (BM (NH)) in London.

MOLLUSCAN ZONES

The basic biostratigraphic unit used in this study is the interval-zone as defined by Hedberg (1976) and by the North American Stratigraphic Code, Article 50, Paragraph 3. Assemblage-zones, concurrent-range-zones, and Oppel-zones are inherently difficult and dangerous to use, being based on more than one taxon. Murphy (1977) pointed out the importance of using a single taxon to define zonal boundaries and described the potential for ambiguity that is introduced when a zone is based on multiple paleontological criteria. Murphy (1977, p. 214) further strongly suggested the use of "the lower boundary of the next overlying unit for the upper boundary of the subjacent unit." That procedure is used in this paper in a system of interval-zones whose boundaries are based on the first appearance datum of selected mollusks. Each zone is further characterized by its distinctive molluscan assemblage. The names given to these zones, as recommended by Hedberg (1976), are derived from the names of the boundary markers—for example, the *Chesapecten santamaria/Glossus fraterna* Interval-zone. The first taxon indicates the lower boundary marker, and the second the upper boundary marker.

Van Hinte (1969), Murphy (1977), and Johnson (1979) all pointed out the necessity of basing zones on the taxa of well-known lineages. Although no single lineage of mollusks is used to establish the zones in this study, multiple lineages and taxa from well-represented groups are used. Thick sequences of marine sediments in the study area preserve much of the biostratigraphic, lithostratigraphic, and chronostratigraphic information that makes the evaluation of definitive lineages possible. Many molluscan genera flourished in the Miocene seas of the middle Atlantic embayments, and they left more than a few well-

represented lineages as a record. The most important lineages in this study are those of *Chesapecten*, *Glossus*, *Costaglycymeris* (new genus), *Marvacrassatella*, *Astarte*, *Mercenaria*, *Leptomactra* (new genus), *Chesacardium* (new genus), *Dallarca* (new genus), *Ecphora*, *Busycon*, and *Busycotypus*. Many other taxa are also relied upon for biostratigraphic information, although their lineages are less well known. Because of the relatively complete phyletic record of the aforementioned taxa and because this record is found over a wide geographic area, a greater degree of confidence may be expressed in their use in the determination of crucial first-appearance data. Although the first appearance of a taxon in a particular bed may not represent that species' true "beginning," by employing taxa from well-represented lineages that area of imprecision is minimized.

Hedberg (1976) has suggested the use of stratotypes when defining biostratigraphic units; however, van Hinte (1968, p. 315) pointed out that a "biozone is defined by the paleontologic concept of the taxon that characterizes the unit; the only 'standard' can be the holotype." Stratotypes are designated here for the proposed interval-zones, and several sections are described where the various units may be best observed.

To avoid the repetition of lengthy formal names of molluscan taxa, the proposed zones are numbered in reverse order (youngest to oldest). The numbers provide the advantage of brevity and indicate the relative position of the various zones to one another. By numbering the zones from top to bottom, an open-ended system is created in which molluscan zones might later be continued into older stratigraphic units. A molluscan zonation for the Pliocene and Pleistocene was proposed by Blackwelder (1981) which includes six zones. The youngest Miocene zone in the present work is, therefore, called molluscan Interval-zone M-7 to continue Blackwelder's (1981) numerical sequence.

Costaglycymeris mixoni/Chesapecten jeffersonius Interval-zone (M-7)

The *Costaglycymeris mixoni/Chesapecten jeffersonius* Interval-zone is proposed as a biostratigraphic unit whose lower boundary is marked by the first appearance of *Costaglycymeris mixoni* Ward, new genus and new species, and whose upper boundary is marked by the first appearance of *Chesapecten jeffersonius* (Say). This zone corresponds to the Cobham Bay Member of the Eastover Formation (Ward and Blackwelder, 1980), which is exposed in southeastern Maryland, the entire coastal plain and Eastern Shore of Virginia, as well as northeastern North Carolina as far south as the Neuse and Trent Rivers. These beds are associated with DE-XV. Molluscan biozone M-7 may be recognized at many localities along rivers, in gullies, and at mill ponds in those three states, but it is best exposed along the Rappahannock and James Rivers in Virginia. At Laytons Landing (for localities referred to in text, see figure 4 and locality register in Appendix), on the right bank of the Rappahannock River, Essex County, Va. (locality 1, figure 5), 1.0 meters of sandy shell beds are exposed that are assignable to Interval-zone M-7. These beds crop out intermittently for three kilometers upriver between Laytons Landing and Bowlers Wharf (locality 2, figure 6). The molluscan assemblage of biozone M-7 found in the sequence of marine beds at this locality is typical for the northern half of the basin in Virginia. There, quiet, shallow, muddy conditions prevailed where *"Spisula" rappahannockensis* (Gardner, 1944) accumulated in vast numbers, much as *Mulinia congesta* (Conrad, 1833) did in the upper Yorktown Formation and *Mulinia lateralis* (Say) does today. In spite of the dominance of this taxon, the remaining molluscan assemblage is quite diverse, consisting of more than 100 species.

The upper boundary of the Interval-zone M-7 cannot be seen in the Bowlers Wharf–Laytons Landing area, but it is well exposed along the James River below Cobham Wharf in Surry County, Va. (locality 3, figure 7). The exposure there is considered to be the stratotype section for M-7. Both the lower and upper boundary may also be seen at Mount Pleasant on the right bank of the James River in Surry County, Va. (locality 4, figure 8). Other exposures of the upper boundary of biozone M-7 are found just above Bush Park Creek on the right bank of the Rappahannock River, Middlesex County, Va. (locality 5, figure 9) and just above Murfreesboro on the right bank of the Meherrin River, Hertford County, N.C. (locality 6, figure 10). These four localities are important because they clearly exhibit the upper Miocene and lower Pliocene contact. Beds assignable to this zone occur on the Rappahannock, Piankatank, Mattaponi, Pamunkey, York, James, and Nottoway Rivers in Virginia, and on the Meherrin, Neuse, and Trent Rivers in North Carolina.

Figure 4.—Base map of the study area showing localities referred to in the text.

The *Costaglycymeris mixoni/Chesapecten jeffersonius* Interval-zone is characterized by an abundant and diversified molluscan assemblage, which reflects warm-temperate to subtropical shallow-shelf, marine conditions (Plates 1–4). Approximately 150 species of mollusks, principally bivalves, flourished at that time. Gastropods were represented by moderate diversity, but bivalves dominated in terms of numbers and size. A number of distinctive molluscan species are restricted to this zone (see Table 1 for stratigraphic ranges of taxa):

Bivalvia
- *Rasia arata* (Say) Pl. 1, fig. 5.
- *Costaglycymeris mixoni* Ward, new species Pl. 1, figs. 2, 3.
- *Carolinapecten urbannaensis* (Mansfield) Pl. 2, fig. 4.
- *Ostrea compressirostra geraldjohnsoni* Ward, new subspecies Pl. 2, fig. 1.
- *Conradostrea greeni* Ward, new species Pl. 1, figs. 7, 9.
- *Marvacrassatella urbannaensis* (Mansfield) Pl. 3, fig. 2.
- *Astarte rappahannockensis* Gardner Pl. 3, fig. 3.
- *Astarte cobhamensis* Ward, new species Pl. 3, fig. 1.
- *Chesacardium laqueatum blountense* (Mansfield) Pl. 3, fig. 4.
- *Lirophora vredenburgi* Ward, new species Pl. 3, fig. 7.

Gastropoda
- *Anguinella virginica* (Conrad) Pl. 4, fig. 4.
- *Ecphora kochi* Ward and Gilinsky Pl. 4, fig. 8.
- *Oliva idonea* Conrad Pl. 4, fig. 5.
- *Conus spenceri* Ward, new species Pl. 4, fig. 6.

Common in the zone but not restricted to it are the following taxa (* indicates that specimen figured is from a zone other than M-7):

Bivalvia
- *Dallarca carolinensis carolinensis* (Dall) Pl. 1, figs. 6, 8.
- *Striarca centenaria* (Say) Pl. 1, fig. 1.
- *Isognomon (Hippochaeta)* sp. Pl. 1, fig. 4.
- *Placopecten princepoides* (Emmons) Pl. 2, fig. 3.
- *Euvola smithi* (Olsson) Pl. 2, fig. 5.
- *Chesapecten (Chesapecten) middlesexensis middlesexensis* (Mansfield) Pl. 2, fig. 2.
- *Stewartia anodonta* (Say) Pl. 8, fig. 6*.
- *Euloxa latisulcata* (Conrad) Pl. 3, fig. 9.
- *Glossus fraterna* (Say) Pl. 6, fig. 8*.
- *Mercenaria druidi* Ward, new species Pl. 3, fig. 8.
- *Panopea goldfussii* Wagner Pl. 4, fig. 2.
- *Kuphus fistula* (H. C. Lea) Pl. 4, fig. 1.
- *"Spisula" rappahannockensis* (Gardner) Pl. 3, figs. 5, 6.

Gastropoda
- *Turritella plebeia plebeia* Say Pl. 4, fig. 3.
- *Busycotypus coronatum* (Conrad) Pl. 4, fig. 7.
- *Bulliopsis quadrata* (Conrad) Pl. 4, fig. 9.

The local extinction of *Isognomon (Hippochaeta)* marks the upper boundary of Zone M-7 and of the Miocene. This taxon was common in the middle Atlantic area during the Late Cretaceous, rare in the Gulf during the Paleocene, absent during the Eocene and Oligocene, but became extremely abundant starting in the middle Miocene and continuing throughout Interval-zone M-7. *Isognomon (Hippochaeta)* sp. survived into the Pliocene in southern Europe.

Ward and Blackwelder (1980) placed the Cobham Bay Member of the Eastover Formation (=M-7) in the late Tortonian (middle late Miocene) based on a radiometric date on glauconite of 8.7±0.4 million years. Additional and supportive evidence was obtained by correlation of the Cobham Bay to the Red Bay Formation in Florida where Akers (1972) reported planktic foraminifers indicative of zone N17.

Paul F. Huddlestun (Georgia Geologic Survey) and the author collected a sample from Laytons Landing (locality 1, figure 5) in Bed C. The following planktics were identified from that sample (Huddlestun, personal communication, 1986):

Neogloboquadrina acostaensis (Blow)
Globigerina nepenthes Todd
Globigerina bulloides d'Orbigny
Globigerinoides quadrilobatus (d'Orbigny)
Globigerinoides obliquus Bolli

Huddlestun interpreted the assemblage to be indicative of zone N17, or the middle upper Miocene.

Glossus fraterna/Costaglycymeris mixoni Interval-zone (M-8)

The lower boundary of the *Glossus fraterna/Costaglycymeris mixoni* Interval-zone is marked by the first appearance of *Glossus fraterna* (Say). Its upper boundary is defined by the first appearance of *Costaglycymeris mixoni* and corresponds with the lower limits of

the overlying Interval-zone M-7. Interval-zone M-8 encompasses a series of clayey, silty, poorly sorted sands that were named the Claremont Manor Member of the Eastover Formation by Ward and Blackwelder (1980). These beds are associated with DE-XIV. Biozone M-8 is best exposed along the James River above and below Claremont, Surry County, Va., and specifically 1.3 km below the mouth of Sunken Meadow Creek, below Claremont (locality 7, figure 11). This is considered to be the principal stratotype section for M-8. Biozone M-8 is directly overlain by beds assignable to M-7 there as well as at Mount Pleasant, the type locality of the Eastover Formation (locality 4, figure 8), and Cobham Wharf (locality 3, figure 7). The lower boundary of M-8 is not exposed below Sunken Meadow Creek as it lies approximately 20 m below river level. However, the lower boundary may be seen at White Oak Landing on the right bank of the Mattaponi River, King William County, Va. (locality 8, figure 12). Locality 8 is considered to be the supplementary reference section for M-8. There beds of the *Glossus fraterna/Costaglycymeris mixoni* Interval-zone (M-8) directly overlie those assigned in this study to the *Chesapecten santamaria/Glossus fraterna* Interval-zone (M-9) (Windmill Point beds of the St. Marys Formation). Upstream and on the left bank, at Rickahock, King and Queen County, Va. (locality 9, figure 13), beds assignable to Interval-zone M-8 directly overlie the diatomaceous clays of the Calvert Formation equivalent to the lower part of Interval-zone M-12. These clays, although they lack macrofossils, can be correlated with Interval-zone M-13 by means of diatoms. Zone M-8 also overlies the Calvert Formation at Elsing Green on the Pamunkey River, King William County, Va. (locality 10, figure 14). Beds probably assignable to biozone M-8 overlie those of M-9 at Mt. Airy Millpond on Clarks Run, Richmond County (locality 11, figure 15).

The molluscan assemblages characteristic of Interval-zone M-8 may be seen along the Potomac River in the high bluffs in Westmoreland County (locality 24), along the Rappahannock River from above and below Carters Wharf, Richmond County (locality 25) to Laytons Landing, Essex County (locality 1, figure 5), along the Mattaponi, Pamunkey, York, and Chickahominy Rivers at numerous small outcrops, and along the James River from the vicinity of Petersburg to some distance below Cobham Wharf, Surry County (locality 3, figure 7), Va., and have been recognized in auger holes as far south as Wakefield, Sussex County, Va. The zone or its equivalents have not been certainly recognized in North Carolina, South Carolina, or Georgia, but small mollusk collections from Florida hint at its presence there.

The deposits encompassed by the *Glossus fraterna/Costaglycymeris mixoni* Interval-zone represent a somewhat restricted, cool-temperate, shallow-shelf, marine embayment. Diversity among mollusks was relatively low, and fossils are generally confined to or concentrated in thin, locally traceable beds. The large amount of silt and clay contained in the beds assigned to biozone M-8 may have been one of the factors inhibiting molluscan productivity and diversity, but cool temperatures are also suspected because of the lack of subtropical mollusks that are common in molluscan zones M-9 and M-7.

A number of distinctive molluscan taxa are restricted to zone M-8 (Plates 5 and 6) (see Table 1 for stratigraphic ranges of the taxa):

Bivalvia
- *Dallarca carolinensis clisea* (Dall) Pl. 5, fig. 3.
- *Dallarca carolinensis rotunda* Ward, new subspecies Pl. 5, figs. 6, 7.
- *Dallarca virginiae* (Dall) Pl. 5, fig. 1.
- *Costaglycymeris virginiae* (Dall) Pl. 5, fig. 2.
- *Chesapecten (Chesapecten) middlesexensis ceccae* Ward, new subspecies Pl. 5, fig. 9.
- *Marvacrassatella surryensis* (Mansfield) Pl. 6, fig. 2.
- *Lirophora dalli* (Olsson) Pl. 6, fig. 6.

Gastropoda
- *Turritella plebeia carinata* Gardner Pl. 6, fig. 9.
- *Ecphora gardnerae whiteoakensis* Ward and Gilinsky Pl. 6, fig. 7.

The following, although not restricted to M-8, are usually abundant in that zone:

Bivalvia
- *Isognomon (Hippochaeta)* sp. Pl. 5, fig. 4.
- *Chesapecten (Chesapecten) middlesexensis middlesexensis* (Mansfield) Pl. 2, fig. 2.
- *Ostrea compressirostra brucei* Ward, new species, Pl. 5, fig. 8.
- *Euloxa latisulcata* (Conrad) Pl. 6 , fig. 5.
- *Glossus fraterna* (Say) Pl. 6, fig. 1.
- *Mercenaria druidi* Ward, new species, Pl. 6, fig. 4.

Other taxa that are common, but not restricted to M-8, are the following (* indicates that specimen figured is from a zone other than M-8):

Bivalvia

Dallarca carolinensis carolinensis (Dall) Pl. 1, figs. 6, 8*.

Lucinoma contracta (Say) Pl. 5, fig. 5.

Panopea goldfussii Wagner Pl. 6, fig. 3.

Ward and Blackwelder (1980) reported the Claremont Manor Member of the Eastover Formation (=M-8) was early Tortonian in age. This was based on radiometric dates on the overlying Cobham Bay Member of the Eastover (8.7±0.4 my) and the underlying St. Marys Formation (12.0±0.5 my). Andrews (1986), on the basis of diatoms, placed the Claremont Manor in the early Tortonian.

Paul F. Huddlestun (Georgia Geologic Survey) examined samples sent to him by the author from the type area of the Claremont Manor Member for planktic foraminifers. The samples came from the bed equivalent to Bed A at locality 7 (figure 11) upriver from Claremont at the mouth of Upper Chippokes Creek. Huddlestun (personal communication, 1986) reports a number of planktics which, as an assemblage, indicate N17 or middle upper Miocene. They are the following taxa:

Globigerina bulloides d'Orbigny
Globigerina apertura Cushman
Globigerina nepenthes Todd
Sphaeroidinellopsis seminuina (Schwager)
Globigerinoides quadrilobatus (d'Orbigny)
Globigerinoides obliquus Bolli
Orbulina universa d'Orbigny
Globoquadrina altispira (Cushman and Jarvis)
Globorotalia conoidea Finlay
Neogloboquadrina acostaensis (Blow)

Chesapecten santamaria/Glossus fraterna Interval-zone (M-9)

The *Chesapecten santamaria/Glossus fraterna* biozone is marked at its lower boundary by the first appearance of *Chesapecten santamaria* (Tucker). Its upper boundary is marked by the first appearance of *Glossus fraterna* (Say) and corresponds with the lower boundary of the overlying biozone M-8. Interval-zone M-9 encompasses the shelly sands that were referred by Shattuck (1904) to his "Zone 24" and included by him in the St. Marys Formation. These beds were named the "Windmill Point bed" by Ward (1984). Beds of the Windmill Point are associated with DE-XIII. Although this zone contains many taxa common to other beds in the St. Marys, it also possesses numerous taxa restricted to that unit. At Windmill Point, on the right bank of the St. Marys River, St. Marys County, Md. (locality 12, figure 16), the lower boundary of Interval-zone M-9 may be seen. This is considered to be the principal reference section for M-9. The upper boundary may be seen at Mt. Airy Millpond (locality 11, figure 15), but it is best seen at White Oak Landing on the Mattaponi River in King William County, Va. (locality 8, figure 12). Locality 8 is considered to be the supplementary reference section for M-9. Beds assignable to biozone M-9 are found on the St. Marys River in Maryland, and the Rappahannock and Mattaponi Rivers in Virginia. Beds of biozone M-9 are not clearly exposed along the Potomac River, apparently because of erosion and the overlapping of Pleistocene age units. Best-preserved molluscan assemblages are found along the St. Marys River at Windmill Point (locality 12, figure 16) and Chancellor Point (locality 13, figure 17) and at Essex Mill, southeast of Tappahannock, Essex County, Va. (locality 14, figure 18). Beds at Islington Landing on the Rappahannock River, Richmond County (locality 20, figure 24), contain M-9 mollusks.

The molluscan assemblages found in Interval-zone M-9 (Plates 7–10) represent a warm-temperate to sub-tropical, shallow-shelf, open-marine environment where sub-tropical taxa are common but warm-temperate species dominate. Mollusks comprise most of the fossil assemblage, and over 100 species have been identified. Bivalves are very abundant but are outnumbered by gastropods such as the nassarids and *Turritella*. Both gastropod and bivalve diversity is relatively high, however.

Mollusks that are restricted to the *Chesapecten santamaria/Glossus fraterna* Interval-zone include the following (see Table 1 for stratigraphic ranges of the taxa):

Bivalvia

Rasia andrewsi Ward, new species Pl. 8, fig. 3.

Dallarca idonea Conrad Pl. 8, figs. 1, 2.

Chesapecten (Chesapecten) santamaria (Tucker) Pl. 7, fig. 4.

Crassostrea sp. Pl. 7, figs. 1, 3.

Astarte perplana Conrad Pl. 7, fig. 5.

Glossus santamaria Ward, new species Pl. 7, fig. 6.

Lirophora alveata (Conrad) Pl. 7, fig. 7.

Mercenaria tetrica (Conrad) Pl. 7, fig. 2.

Gastropoda
Turritella subvariabilis d'Orbigny Pl. 8, fig. 4.
Urosalpinx subrusticus (d'Orbigny) Pl. 9, fig. 2.
Conus deluvianus Green Pl. 9, fig. 1.
Ecphora gardnerae gardnerae Wilson Pl. 10, figs. 1, 2.

Other mollusks that are common to abundant but not restricted to this interval zone are the following (* indicates that the specimen figured is from a zone other than M-9):

Bivalvia
Stewartia anodonta (Say) Pl. 8, fig. 6.
Chesacardium laqueatum laqueatum (Conrad) Pl. 8, fig. 9.
Mactrodesma subponderosa (d'Orbigny) Pl. 9, figs. 4, 6.
Leptomactra delumbis (Conrad) Pl. 8, fig. 8.
Dosinia acetabulum thori Ward, new subspecies Pl. 8, fig. 7.
Panopea goldfussii Wagner Pl. 12, fig. 4*.
Gastropoda
Turritella plebeia plebeia Say Pl. 8, fig. 5.
Busycotypus coronatum (Conrad) Pl. 10, fig. 3.
Busycotypus rugosum (Conrad) Pl. 10, fig. 4.
Nassarius (Tritiaria) peralta (Conrad) Pl. 9, fig. 3.
Bulliopsis quadrata (Conrad) Pl. 4, fig. 9*.
Buccinofusus parilis (Conrad) Pl. 9, fig. 5.

Ward and Blackwelder (1980) reported a radiometric date on the Little Cove Point beds of the St. Marys Formation of 12.0±0.5 my. Gibson (1982) placed the St. Marys Formation in the lower upper Serravallian Stage or upper middle Miocene. More recently Gibson (1983*a*), in a correlation chart, placed the upper beds of the St. Marys (equivalent to the Windmill Point beds) in the lower Tortonian or lower upper Miocene. Gibson (1983*b*) stated that planktic foraminifers were rare in the St. Marys and none were diagnostic, but Gibson and Bybell (1984) reported *Globorotalia acostaensis acostaensis* from the unit and placed it in the upper Miocene.

Paul F. Huddlestun (Georgia Geologic Survey) and the author sampled the Windmill Point beds at Essex Mill (locality 18) in 1976. Huddlestun reports the following planktic foraminifers from that locality (personal communication, 1986):

Neogloboquadrina acostaensis (Blow)
Globigerina bulloides d'Orbigny
Globigerina cf. *apertura* Cushman
Globigerinoides quadrilobatus (d'Orbigny)

He reports that this assemblage is no lower than N16, which places it in the upper Miocene. Planktics examined by him from the type area of the Claremont Manor Member were indicative of N17. He considers that the Windmill Point beds are N16 or lower upper Miocene.

Ecphora gardnerae germonae/Chesapecten santamaria Interval-zone (M-10)

The *Ecphora gardnerae germonae/Chesapecten santamaria* biozone is marked at its lower boundary by the first appearance of *Ecphora gardnerae germonae* Ward and Gilinsky, while its upper boundary is marked by the first appearance of *Chesapecten santamaria* (Tucker) and corresponds with the lower boundary of the overlying biozone M-9. Beds included in this Interval-zone are those assigned to "Zones 21–23" by Shattuck (1904). "Zones 21–23," herein referred to as beds, were included in the "Little Cove Point beds" by Ward (1984) and were considered a part of the St. Marys Formation. The Little Cove Point beds are associated with DE-XII. Biozone M-10 may be recognized in cliffs along the Chesapeake Bay in the lower half of Calvert County, Md., but it is best exposed just below Little Cove Point (locality 15, figure 19). That is considered to be the stratotype for M-10. The lower boundary can be seen there just above beach level and corresponds to the contact between the Conoy Member and the Little Cove Point beds of the St. Marys Formation. The lower boundary may also be seen at Drumcliff, on the right bank of the Patuxent River, St. Marys County, Md. (locality 16, figure 20), and along the western shore of the Chesapeake Bay from the Baltimore Gas and Electric atomic power plant (locality 17, figure 21) to the Calvert Cliffs State Park. The farthest up-bay that beds assignable to biozone M-10 may be recognized is just south of the mouth of Parker Creek at Scientists Cliffs (locality 18, figure 22), where it is present in the upper three meters of the bluff. The farthest downbay that the unit is known is at Langleys Bluff in St. Marys County, where it is beveled off and overlain by upper Pleistocene estuarine deposits (locality 22, figure 26). The upper boundary of the zone is not clear along the bay section because of weathering of the upper beds, but may be seen along

the St. Marys River at Windmill Point (locality 12, figure 16) and just above Portobello Point (locality 19, figure 23). Beds assignable to biozone M-10 are not definitely known south of the Potomac River, but may be present in the thin clayey strata overlying beds assigned to biozone M-11 in the bluffs along the Potomac River in Westmoreland County (locality 24, figure 28).

The molluscan assemblages of the *Ecphora gardnerae germonae/Chesapecten santamaria* Interval-zone (M-10) indicate warm-temperate, shallow, inner bay conditions in an open-marine environment. Far updip exposures consist of fine silty sands that reflect shallow, muddy substrates, and at some intervals exhibit ripple marks. Farther seaward to the east, in the area of Little Cove Point (locality 15, figure 19) and Langleys Bluff (locality 22, figure 26), higher-energy conditions existed, as indicated by sandier sediments, some current-bedding, and abraded, size-sorted, current-oriented mollusks. Most of the updip exposures of beds assignable to biozone M-10 are thoroughly leached and contain only molds and casts. However, large-scale slumping in the Baltimore Gas and Electric power plant area (locality 17, figure 21) has exposed large molluscan faunas along thin bedding planes in the dominantly silty clay beds. These assemblages are dominated by large colonies of *Pinna*, as is the case today in some quiet, lagoonal marginal-marine settings. Downbay, in the sandier facies, the molluscan assemblage is well-preserved, very diverse, and consists, almost equally, of bivalves and gastropods. Mollusks, for the most part, are concentrated in bands of variable thickness and number over 100 species (Plates 11–13).

Mollusks that are restricted to biozone M-10 include the following (see Table 1 for stratigraphic ranges of the taxa):

Bivalvia
- *Chesapecten (Chesapecten) covepointensis* Ward, new species Pl. 11, figs. 2, 3, 6.
- *"Spisula" subcuneata* (Conrad) Pl. 11, fig. 4.

Gastropoda
- *Turritella subvariabilis bohaskai* Ward, new subspecies Pl. 13, figs. 4, 5.
- *Ecphora gardnerae germonae* Ward and Gilinsky Pl. 13, figs. 1, 2.

Mollusks that are common to biozone M-10 but not restricted to it are the following (* indicates that the specimen figured is from a zone other than M-10):

Bivalvia
- *Dallarca idonea* ssp. Pl. 11, figs. 1, 5.
- *Stewartia anodonta* (Say, 1824) Pl. 8, fig. 6*.
- *Chesacardium laqueatum eschelmani* Ward, new subspecies Pl. 12, fig. 2.
- *Mactrodesma subponderosa* d'Orbigny Pl. 12, fig. 6.
- *Mercenaria cuneata* ssp. Pl. 12, fig. 5.
- *Mercenaria tetrica* ssp. Pl. 12, fig. 7.
- *Dosinia acetabulum thori* Ward, new subspecies Pl. 12, fig. 1.
- *Clementia inoceriformis* (Wagner) Pl. 12, fig. 3.
- *Panopea goldfussii* Wagner Pl. 12, fig. 4.

Gastropoda
- *Turritella plebeia plebeia* Say Pl. 8, fig. 5*.
- *Busycon fusiforme* (Conrad) Pl. 13, fig. 9.
- *Busycotypus coronatum* (Conrad) Pl. 13, fig. 8.
- *Busycotypus rugosum* (Conrad) Pl. 13, fig. 10.
- *Nassarius (Tritiaria) peralta* (Conrad) Pl. 9, fig. 3*.
- *Bulliopsis marylandica* (Conrad) Pl. 13, fig. 3.
- *Terebra simplex* Conrad Pl. 13, fig. 6.

Taxa making their first appearance in Interval-zone M-10 are the following (* indicates that the specimen figured is from a zone other than M-10):

Bivalvia
- *Mactrodesma subponderosa* d'Orbigny Pl. 12, fig. 6.
- *Dosinia acetabulum thori* Ward, new subspecies Pl. 12, fig. 1.

Gastropoda
- *Ecphora gardnerae germonae* Ward and Gilinsky Pl. 13, figs. 1, 2.
- *Busycon fusiforme* (Conrad) Pl. 13, fig. 9.
- *Busycotypus coronatum* (Conrad) Pl. 13, fig. 8.
- *Busycotypus rugosum* (Conrad) Pl. 13, fig. 10.
- *Nassarius (Tritiaria) peralta* (Conrad) Pl. 9, fig. 3*.
- *Bulliopsis marylandica* (Conrad) Pl. 13, fig. 3.
- *Buccinofusus chesapeakensis* Petuch Pl. 13, fig. 7.
- *Terebra simplex* Conrad Pl. 13, fig. 6.

Ward and Blackwelder (1980) reported a radiometric date on the Little Cove Point beds based on glauconite of 12.0±0.5 my. Gibson (1982, 1983*a*) placed the lower St. Marys in the upper middle Miocene. Gibson and Bybell (1984) placed the entire St. Marys in the upper Miocene and indicated on a chart (p. 187, fig. 3) that the planktic foraminifer *Globorotalia acostaensis acostaensis* occurred throughout the St. Marys. Huddlestun (personal communication,

1986) stated that such an occurrence in the Little Cove Point beds would mean that the unit is no older than late Miocene. Since the Little Cove Point beds underlie the Windmill Point beds, which has been determined by Huddlestun (personal communication) to be lower upper Miocene, it is believed that this lower bed may be lower upper Miocene also.

Marvacrassatella marylandica/ Ecphora gardnerae germonae Interval-zone (M-11)

The *Marvacrassatella marylandica/Ecphora gardnerae germonae* Interval-zone is marked at its lower boundary by the first appearance of *Marvacrassatella marylandica* Conrad. Its upper boundary is marked by the first appearance of *Ecphora gardnerae germonae*, which is also the lower boundary marker for Interval-zone M-10. Beds that correspond to Interval-zone M-11 were called "Zones" 19 and 20 of the Choptank Formation (Shattuck, 1904) and more recently the Boston Cliffs Member and Conoy Member of the Choptank (Gernant, 1970). The Conoy has since been placed in the St. Marys Formation (Ward, 1984). The Boston Cliffs is equivalent to DE-X and the Conoy is equivalent to DE-XI. Zone M-11 is best exposed 0.8 km above the Baltimore Gas and Electric power plant on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 17, figure 21). That locality is considered to be the stratotype for M-11 and both the upper and lower boundaries of the molluscan zone can be seen there. Beds assignable to Interval-zone M-11 are well exposed along the western shore of the Chesapeake Bay from Scientists Cliffs (locality 18, figure 22) to Cove Point and along the Patuxent River from Drumcliff (locality 16, figure 20) to Hellen Creek (locality 21, figure 25). The zone may also be recognized along the southeastern end of the Westmoreland Bluffs in Westmoreland County, Va. (locality 24, figure 28).

Molluscan assemblages in biozone M-11 indicate mild-temperate, shallow-shelf, open-marine conditions. The molluscan diversity is moderate, and large numbers of individuals are present in this zone. Gastropod diversity is low relative to Interval-zones 10 and 12. The area of the basin where sandy substrates were prevalent proved favorable for the proliferation of several of the taxa (Plates 14, 15).

Mollusks that are known only from biozone M-11 are the following (see Table 1 for stratigraphic ranges of the taxa):

Bivalvia
- *Dallarca elevata* (Conrad) Pl. 14, figs. 9, 10.
- *Chesapecten (Chesapecten) monicae* Ward, new species Pl. 14, figs. 1–6.
- *Astarte obruta* Conrad Pl. 15, fig. 3.
- *Marvacrassatella marylandica* Conrad Pl. 14, figs. 7, 8.
- *Chesacardium laqueatum vostreysi* Ward, new subspecies Pl. 15, fig. 6.

Gastropoda
- *Turritella terebriformis* Dall Pl. 15, fig. 5.
- *Ecphora meganae williamsi* Ward and Gilinsky Pl. 15, figs. 1, 2.

Mollusks that are not restricted to biozone M-11, but are common in that zone, are the following (* indicates that the specimen figured is from a zone other than M-11):

Bivalvia
- *Chesapecten (Chesapecten) nefrens* Ward and Blackwelder Pl. 15, fig. 4.
- *Timothynus subvexa* (Conrad) Pl. 19, fig. 3*.
- *Stewartia anodonta* (Say) Pl. 19, fig. 1*.
- *Florimetis biplicata* (Conrad) Pl. 16, fig. 4*.
- *Glossus marylandica* (Schoonover) Pl. 18, fig. 4*.
- *Macrocallista marylandica* (Conrad) Pl. 18, fig. 1*.
- *Dosinia acetabulum blackwelderi* Ward new subspecies Pl. 18, fig. 2*.
- *Mercenaria cuneata* Conrad Pl. 18, fig. 3*.
- *Pleiorytis calvertensis* (Dall) Pl. 17, fig. 6*.
- *Bicorbula idonea* (Conrad) Pl. 21, fig. 1*.
- *Panopea americana* Conrad Pl. 16, fig. 5*.

Beds associated with M-11 are the Boston Cliffs Member of the Choptank Formation and the Conoy Member of the St. Marys Formation. Abbott (1978, 1982) considered those beds to be in his diatom Zone VI (in part, *Coscinodiscus plicatus* zone). Abbott believed his Zone VI to be equivalent to foraminiferal Zone N12 and the upper part of the Serravallian Stage. Andrews (1978) placed the beds in his Zone 7 and considered them to be of late Seravallian age or upper late Miocene.

Marvacrassatella turgidula/ Marvacrassatella marylandica Interval-zone (M-12)

The *Marvacrassatella turgidula/Marvacrassatella marylandica* Interval-zone is marked at its lower boundary by the first appearance of *Marvacrassatella turgidula* Conrad. Its upper boundary is marked by the first appearance of *Marvacrassatella marylandica* Conrad and coincides with the lower boundary of Interval-zone M-11. Biozone M-12 includes beds assigned to "Zones" 14 and 15 of the Calvert Formation and 17 and 18 of the Choptank Formation by Shattuck (1904) and to the Calvert Beach Member (as amended by Ward, 1984) of the Calvert Formation and the Drumcliff and St. Leonard Members of the Choptank of Gernant (1970). These beds comprise DE-VIII and -IX of Ward (1985*a*). One of the best exposures of the beds assigned to this zone is at Drumcliff, on the right bank of the Patuxent River, St. Marys County, Md. (locality 16, figure 20). The lower portion of biozone M-12 is not exposed at Drumcliff but it may be seen a short distance upstream at Queen Tree Landing on the right bank of the Patuxent River, St. Marys County (locality 23, figure 27), where the Calvert Beach Member is exposed. The lower boundary may be seen along the Chesapeake Bay from the high bluffs upbay from Scientists Cliffs (locality 18, figure 22) to Calvert Beach, both in Calvert County. The section above Scientists Cliffs is considered to be the stratotype section for M-12. In Virginia, the lower portion of the zone may be seen along the southeastern section of the Westmoreland Bluffs, Westmoreland County (locality 24, figure 28). It is also present, but the mollusks are poorly preserved, above and below Carters Wharf, Richmond County, Va. (locality 25, figure 29). The upper boundary may be seen at Drumcliff (locality 16, figure 20) where it is overlain by beds assigned to biozone M-11. This upper boundary may be seen along the Chesapeake Bay from Scientists Cliffs (locality 18, figure 22) to near the Calvert Cliffs State Park, Calvert County, Md. The beds that comprise the upper part of biozone M-12 (Beds 17, 18) are missing in the Westmoreland Bluffs and Bed 19 (Interval-zone M-11) directly overlies Bed 14/15 there. Below Carters Wharf (locality 25, figure 29) on the Rappahannock River in Richmond County, Bed 14/15 (Interval-zone M-12) is directly overlain by a thin, weathered, blocky clay which may be the St. Marys Formation.

The molluscan assemblage present in the lower portion of biozone M-12 represents initially temperate, shallow-shelf, open-marine conditions that were favorable for the development of a moderately diverse molluscan fauna (Plates 16–19). Later, temperatures rose, culminating in a warm-temperate assemblage. Prevailing conditions allowed the proliferation of great numbers of individuals while diversity was slightly lower than the later biozones M-10 and M-9. Bivalves are by far the dominant taxa in terms of diversity and biomass.

Molluscan taxa known only from biozone M-12 are the following (see Table 1 for stratigraphic ranges of the taxa):

Bivalvia
- *Dallarca elnia* (Glenn) Pl. 16, fig. 6.
- *Chesapecten*(?) *skiptonensis* (Mansfield) Pl. 18, figs. 5, 8.
- *Chesapecten* (*Christinapecten*) *marylandica* (Wagner) Pl. 16, fig. 1.
- *Astarte thisphila* Glenn Pl. 19, fig. 4.
- *Marvacrassatella turgidula* (Conrad) Pl. 17, figs. 1, 2.
- *Leptomactra marylandica* (Dall) Pl. 17, figs. 3, 5.
- *Lirophora parkeria* (Glenn) Pl. 18, figs. 6, 7.

Gastropoda
- *Turritella subvariabilis dianae* Ward, new subspecies Pl. 19, fig. 8

Lirophora parkeria (Glenn) and *Chesapecten*(?) *skiptonensis* (Mansfield) both occur only in the basal portion of M-12 in the Calvert Beach Member of the Calvert Formation (Bed 14/15). The two taxa are not known from the Choptank Formation.

Mollusks that are quite common in M-12 but not restricted to it include the following (* indicates that the specimen figured is from a zone other than M-12):

Bivalvia
- *Chesapecten* (*Chesapecten*) *nefrens* Ward and Blackwelder Pl. 16, fig. 2.
- *Stewartia anodonta* (Say) Pl. 19, fig. 1.
- *Lucinoma contracta* (Say) Pl. 19, fig. 2.
- *Timothynus subvexa* (Conrad) Pl. 19, fig. 3.
- *Chesacardium laqueatum blackwelderi* Ward, new subspecies Pl. 17, fig. 4.
- *Florimetis biplicata* (Conrad) Pl. 16, fig. 4
- *Glossus marylandica* (Schoonover) Pl. 18, fig. 4.

Macrocallista marylandica (Conrad) Pl. 18, fig. 1.
Mercenaria cuneata Conrad Pl. 18, fig. 3.
Dosinia acetabulum blackwelderi Ward, new subspecies Pl. 18, fig. 2.
Pleiorytis calvertensis (Dall) Pl. 17, fig. 6.
Bicorbula idonea (Conrad) Pl. 21, fig. 1*.
Panopea goldfussii Wagner Pl. 16, fig. 3.
Panopea americana Conrad Pl. 16, fig. 5.

Gastropoda
Scaphella virginiana Dall Pl. 19, fig. 9.
Ecphora meganae meganae Ward and Gilinsky Pl. 19, figs. 6, 7.

Abbott (1978, 1982) described two diatom zones, V and VI, in the stratigraphic interval included in M-12 and assigned them to the middle Serravallian Stage of the middle middle Miocene. Andrews (1978) placed the interval in his diatom Zones 5 and 6. He concurred with the middle Serravallian assignment. No planktic foraminifers are known from this interval.

Pecten humphreysii/Marvacrassatella turgidula Interval-zone (M-13)

The *Pecten humphreysii/Marvacrassatella turgidula* Interval-zone is marked at its lower boundary by the first appearance of *Pecten humphreysii* Conrad. Its upper boundary is marked by the first appearance of *Marvacrassatella turgidula* Conrad and coincides with the lower boundary of Interval-zone M-12. Biozone M-13 encompasses beds of early and early middle Miocene age that have been assigned to the Kirkwood Formation in New Jersey by Knapp (1904), to the Fairhaven and Plum Point Marl Members of the Calvert Formation in Virginia and Maryland by Shattuck (1902, 1904), and to the Pungo River Formation in North Carolina by Kimrey (1964). The zone corresponds to Beds ("Zones") 2–13 of Shattuck (1904) and is associated with DE-III, -IV, -V, -VI, and -VII of Ward (1985*a*). Bed 1 of Shattuck may also fall within this zone, but its mollusks consist only of molds and casts, and the bed is difficult to place in this study. Interval-zone M-13 is well-exposed at the upbay portion of Randle Cliffs, 1.3 km below Chesapeake Beach on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 26, figure 30), which is considered to be the stratotype for the unit.

The lower boundary of Zone M-13 is also marked by the first appearance of *Lucinoma contracta* (Say, 1824), *Ecphora tricostata pamlico* Wilson, 1987 and other taxa, but the zone is not based on those species. More than 30 meters of the beds assigned to the zone are exposed at Randle Cliffs (locality 26, figure 30) but the lower boundary is not exposed there. The lower boundary can be seen at a small exposure on the Patuxent River, 0.5 km above Jones Point on the left bank, Calvert County, Md. (locality 27, figure 31). Locality 27 is considered to be the supplementary reference section for M-13.

The upper boundary of Interval-zone M-13 may be seen high in the section at Randle Cliffs; however, it is inaccessible. The upper boundary is accessible 1.0 km south of Parker Creek on the western shore of the Chesapeake Bay (locality 18, figure 22). There biozone M-13 is overlain by beds assigned to M-12.

Beds assignable to Interval-zone M-13 are present in New Jersey, on the Eastern Shore of Maryland, along the western shore of the Chesapeake Bay from Fairhaven to near Governor Run in Calvert County, along the Patuxent River from near Lower Marlboro in Calvert County to upriver of Queen Tree Landing in St. Marys County, and along the Potomac River from five kilometers above Popes Creek, Charles County, Md., to the mouth of Popes Creek in Westmoreland County, Va. Strata equivalent to that zone are found in the high hills around the periphery of Washington, D.C. In Virginia, biozone M-13 may be recognized along the Potomac, but farther south along the Rappahannock and Mattaponi Rivers, equivalent beds contain few or no mollusks, making its recognition difficult. Correlation, in those cases, is made by means of diatoms. Ward (1984, p. 57, 272) identified mollusks along the Pamunkey River near Grimes Landing, King William County, Va., that are suggestive of M-13 and were in beds equivalent to Bed 10–11 ("Zone 10/11" of Shattuck, 1904). Mollusks associated with M-13 have also been identified in the Pungo River Formation at Aurora, Beaufort County, N.C. Key taxa in the Pungo River were *Pecten humphreysii* (Conrad), *Chesapecten (Chesapecten) coccymelus* (Dall), and *Marvacrassatella melina* (Conrad).

The molluscan assemblage present in Interval-zone M-13 reflects warm-temperate to sub-tropical, shallow-shelf to protected lagoonal, marine conditions (Plates 20–23). Inner bay settings, especially in Virginia, apparently protected from currents and wave energy, were the site of large accumulations of silts, clays, and diatoms. Soft bottom conditions prevented mollusk accumulations in these areas, but farther

seaward where silty sands and sands were the dominant substrate, mollusks flourished. These beds, notably "Zones" 10 and 12 of Shattuck (1904), contain the bulk of invertebrate fossils known from biozone M-13.

Mollusks restricted to Interval-zone M-13 are the following (see Table 1 for stratigraphic ranges of the taxa):

Bivalvia
- *Dallarca subrostrata* (Conrad) Pl. 20, fig. 5.
- *Glycymeris parilis* (Conrad) Pl. 20, fig. 2.
- *Eburneopecten cerinus* Conrad Pl. 20, fig. 6.
- *Pecten humphreysii* Conrad Pl. 20, fig. 4.
- *Chesapecten (Chesapecten) coccymelus* (Dall) Pl. 20, figs. 1, 3.
- *Hyotissa haitensis* (Sowerby) Pl. 20, figs. 7, 8.
- *Pycnodonte percrassa* (Conrad) Pl. 21, fig. 3.
- *Stewartia foremani* (Conrad) Pl. 21, figs. 7, 8.
- *Astarte cuneiformis* Conrad Pl. 22, fig. 5.
- *Marvacrassatella melina* (Conrad) Pl. 22, fig. 8.
- *Chesacardium craticuloides* (Conrad) Pl. 21, fig. 5.
- *Glossus markoei* (Conrad) Pl. 22, figs. 3, 4.
- *Glossus mazlea* (Glenn) Pl. 22, figs. 1, 2.
- *Lirophora latilirata* (Conrad) Pl. 23, fig. 5.
- *Mercenaria blakei* Ward, new species Pl. 22, fig. 6.
- *Melosia staminea* (Conrad) Pl. 21, fig. 6.
- *Varicorbula elevata* (Conrad) Pl. 21, fig. 2.

Gastropoda
- *Turritella indenta* Conrad Pl. 23, fig. 10.
- *Turritella exaltata* Conrad Pl. 23, figs. 6, 9.
- *Ecphora tricostata pamlico* Wilson Pl. 23, figs. 3, 4.
- *Ecphora tricostata tricostata* Martin Pl. 23, figs. 1, 2, 7, 8.

Mollusks that are common in beds assigned to biozone M-13, but not restricted to that unit, are the following (* indicates that the specimen figured is from a zone other than M-13):

Bivalvia
- *Stewartia anodonta* (Say) Pl. 21, fig. 9.
- *Macrocallista marylandica* (Conrad) Pl. 22, fig. 7.
- *Dosinia acetabulum blackwelderi* Ward, new subspecies Pl. 18, fig. 2*.
- *Bicorbula idonea* (Conrad) Pl. 21, fig. 1.
- *Panopea goldfussii* Wagner Pl. 16, fig. 3*.
- *Panopea americana* Conrad Pl. 16, fig. 5*.

Molluscan Interval-zone M-13 includes DE-III and -IV (upper part of the Fairhaven Member of the Calvert Formation) and DE-V, -VI, and -VII (the Plum Point Marl Member of the Calvert Formation). Abbott (1978, 1982) and Andrews (1978) considered the lowest part of the sequence (=DE-III of this report) to be early Miocene in age and equivalent to the upper Burdigalian Stage. The remainder of the beds were considered to be early middle Miocene age and equivalent to the Langhian Stage. Gibson (1983*b*) considered Bed 10 of the Calvert (=DE-VI) to be within planktic foraminifer Zone N8 and the overlying unit, Bed 12 (=DE-VII), to be N9. These zones would also indicate equivalence with the Langhian Stage in the lower middle Miocene.

Dimarzipecten crocus/Pecten humphreysii Interval-zone (M-14)

The *Dimarzipecten crocus/Pecten humphreysii* Interval-zone is marked at its lower boundary by the first appearance of *Dimarzipecten crocus* (Cooke). Its upper boundary is marked by the first appearance of *Pecten humphreysii* Conrad and coincides with the lower boundary of Interval-zone M-13.

Biozone M-14 consists of shelly sands of late Oligocene/early Miocene age that were assigned to the Haywood Landing Member of the Belgrade Formation by Ward and others (1978), and the Old Church Formation by Ward (1985*d*). Also included is Bed 1 of the Fairhaven Member of the Calvert Formation. These units involve DE-I and -II of Ward (1985*a*). The only known natural exposure of beds assigned to M-14 in North Carolina is at Haywood Landing on the left bank of the White Oak River, Jones County, N.C. (locality 28, figure 32; type locality of the Haywood Landing Member). Locality 28 is considered to be the stratotype of M-14 because it is the only known natural exposure. Quarries at Belgrade and Silverdale, both in Onslow County, N.C., temporarily provide better exposures of the zone than at Haywood Landing. At the Martin Marietta Company Belgrade Quarry (locality 29, figure 33) a thick section is exposed where the lower boundary of biozone M-14 may be seen in contact with beds assigned to the upper Oligocene River Bend Formation (Ward et al., 1978). At the Silverdale Marl Company Quarry at Silverdale (locality 30, figure 34), three meters of sandy shell marl are exposed that are assignable to Interval-zone M-14. No exposure exhibits the upper boundary of biozone M-14 at Silverdale, but mollusk specimens found on spoil piles

there indicate the possible presence of at least part of biozone M-13. Both localities 33 and 34 are considered to be supplementary reference sections of M-14.

Beds assignable to biozone M-14 are in the shallow subsurface of Jones and Onslow Counties, N.C., and are known in Virginia in outcrop and in the subsurface. In Maryland the unit is known only in the subsurface. In Virginia, beds of the Old Church Formation (Ward, 1985*d*), which is tentatively assigned to M-14, crop out along the Pamunkey River (locality 31, figure 35) and were exposed in a sand pit (Warren Brothers Pit) next to the Chickahominy River (locality 32, figure 36).

The occurrence of *Dimarzipecten crocus* in the Edisto Formation (Ward et al., 1979) in South Carolina suggests the presence of biozone M-14 in that area. *Dimarzipecten crocus* has also been found in the Tampa Limestone of Florida and was originally named from Anguilla in the Leeward Islands.

The molluscan assemblage present in Interval-zone M-14 represents warm-temperate to subtropical, shallow-shelf, open-marine conditions (Plates 24–26). Diversity among mollusks was high, as were numbers of individuals. Many subtropical to tropical forms are present in the North Carolina, South Carolina, and Florida localities indicating relatively equitable climatic conditions over that distance, but the assemblage in Virginia is more warm-temperate in nature.

Mollusks that are restricted to biozone M-14 include the following (see table 1 for stratigraphic ranges of the taxa):

Bivalvia
- *Cunearca silverdalensis* (Kellum) Pl. 24, fig. 11.
- *Rebeccapecten berryae* Ward, new species Pl. 24, fig. 1.
- *Dimarzipecten crocus* (Cooke) Pl. 24, fig. 2.
- *Chama chipolana* Dall Pl. 24, figs. 6–9.
- *Glyptoactis nodifera* (Kellum) Pl. 25, fig. 1.
- *Cyclocardia trentensis* Ward, new species Pl. 25, fig. 2.
- *Astarte claytonrayi* Ward, new species Pl. 24, figs. 3, 5.
- *Astarte onslowensis* Kellum Pl. 24, fig. 4.
- *Dinocardium taphrium* (Dall) Pl. 25, fig. 3.
- *Donax idoneus* Conrad Pl. 25, fig. 9.
- *Macrocallista acuminata* Dall Pl. 25, figs. 4, 6.
- *Anomalocardia floridana* Conrad Pl. 25, fig. 8.
- *Chione spada* Dall Pl. 25, fig. 7.
- *Mya wilsoni* Ward, new species Pl. 25, figs. 10–12.

Gastropoda
- *Sinum imperforatum* Dall Pl. 26, fig. 5.
- *Tritonopsis gilletti* (Richards) Pl. 26, fig. 11.
- *Tritonopsis biconica* (Dall) Pl. 26, fig. 10.
- *Ecphora tampaensis* (Dall) Pl. 26, figs. 6–9.
- *Typhis siphonifera* Dall Pl. 26, fig. 4.
- *Busycon spiniger onslowensis* Kellum Pl. 26, fig. 2.
- *Fusinus hoffmani* Ward, new species Pl. 26, fig. 1.

Mollusks common in biozone M-14, but which are not restricted to that unit, are the following:

Bivalvia
- *Anomia ruffini* Conrad Pl. 24, fig. 12.
- *Stewartia anodonta* (Say) Pl. 24, fig. 10.
- *Mercenaria capax* (Conrad) Pl. 25, fig. 5.

Gastropoda
- *Turritella tampae* Heilprin Pl. 26, fig. 3.

Molluscan zone M-14 includes the Belgrade Formation in North Carolina, the Old Church Formation in Virginia and Maryland, and Bed 1 of the Fairhaven Member of the Calvert Formation in Maryland. Ward and others (1978) placed the Belgrade Formation in the lower Miocene. Ward and Blackwelder (1980) reiterated this placement. Ward (1984, 1985*d*) cited numerous microfossil groups and concluded that the evidence indicated a latest Oligocene or earliest Miocene age. The unit may straddle the boundary.

SUMMARY

A relatively complete record of Miocene marine environments and their accompanying fossil assemblages is present on the Coastal Plain of Maryland, Virginia, and North Carolina. Shallow-shelf environments during this time were favorable to the proliferation of large molluscan assemblages, many of whose taxa may be followed through the entire stratigraphic sequence. The lack of appreciable diagenesis was favorable for the excellent preservation of most of these faunas. The result is an unequalled onshore record of depositional events and successive fossil molluscan assemblages during the Miocene in the western Atlantic. This, combined with the overall accessibility of the deposits by almost continuous natural exposure on large and easily navigable rivers, makes the area ideal for the establishment of molluscan zones for this period. Taxa with wide geographic ranges make these biostratigraphic units recognizable over considerable distances. The need for a biostrati-

graphic framework is evident in the Atlantic Coastal Plain Miocene of North America. The molluscan zones here proposed are based principally on the first occurrence of single taxa, giving some flexibility to the units' boundaries as more biostratigraphic information becomes available. The establishment of stratotypes fixes the boundaries of the zones at various localities.

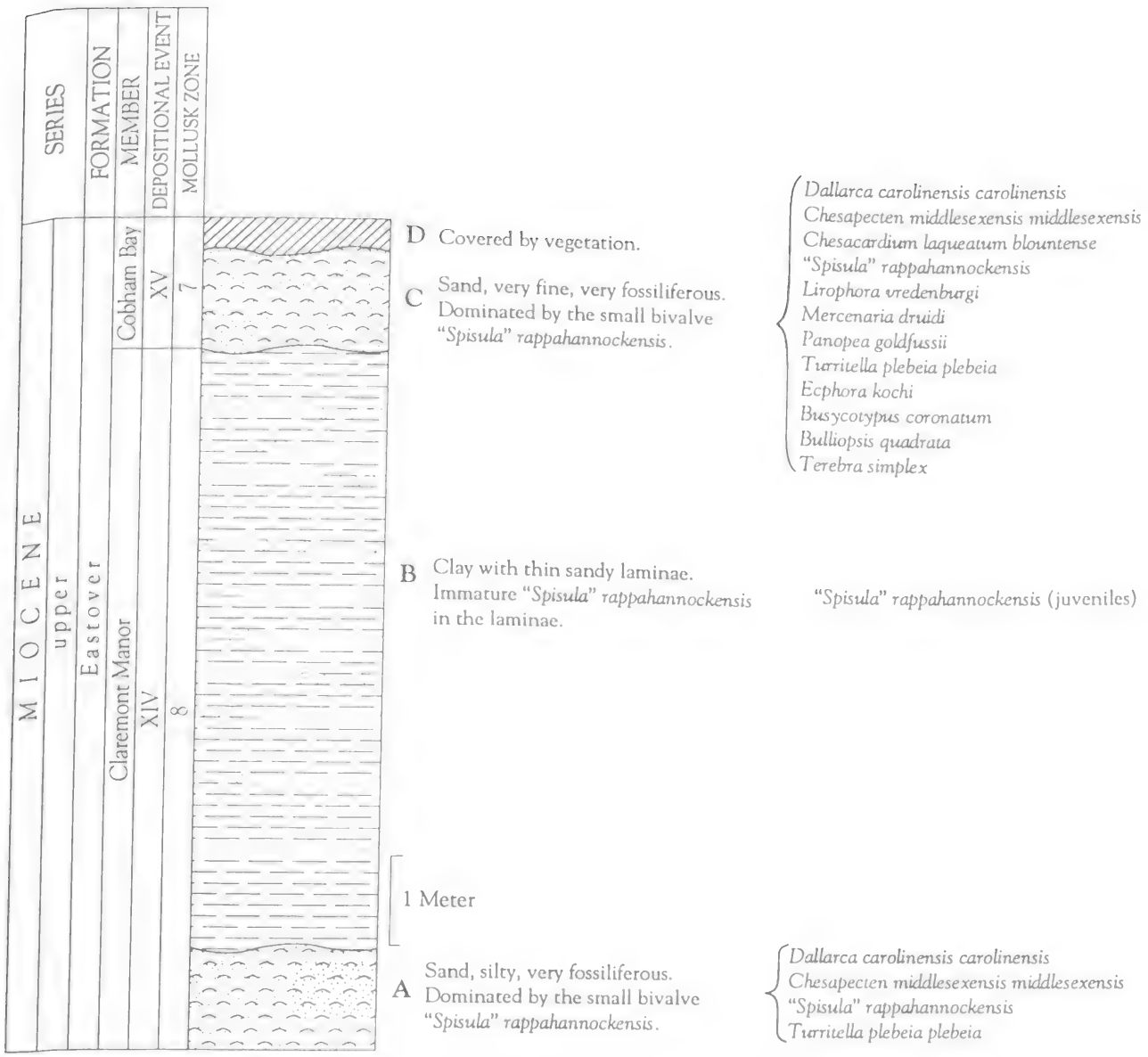


Figure 5.—Stratigraphic section at Laytons Landing, Essex County, Va. (Locality 1).

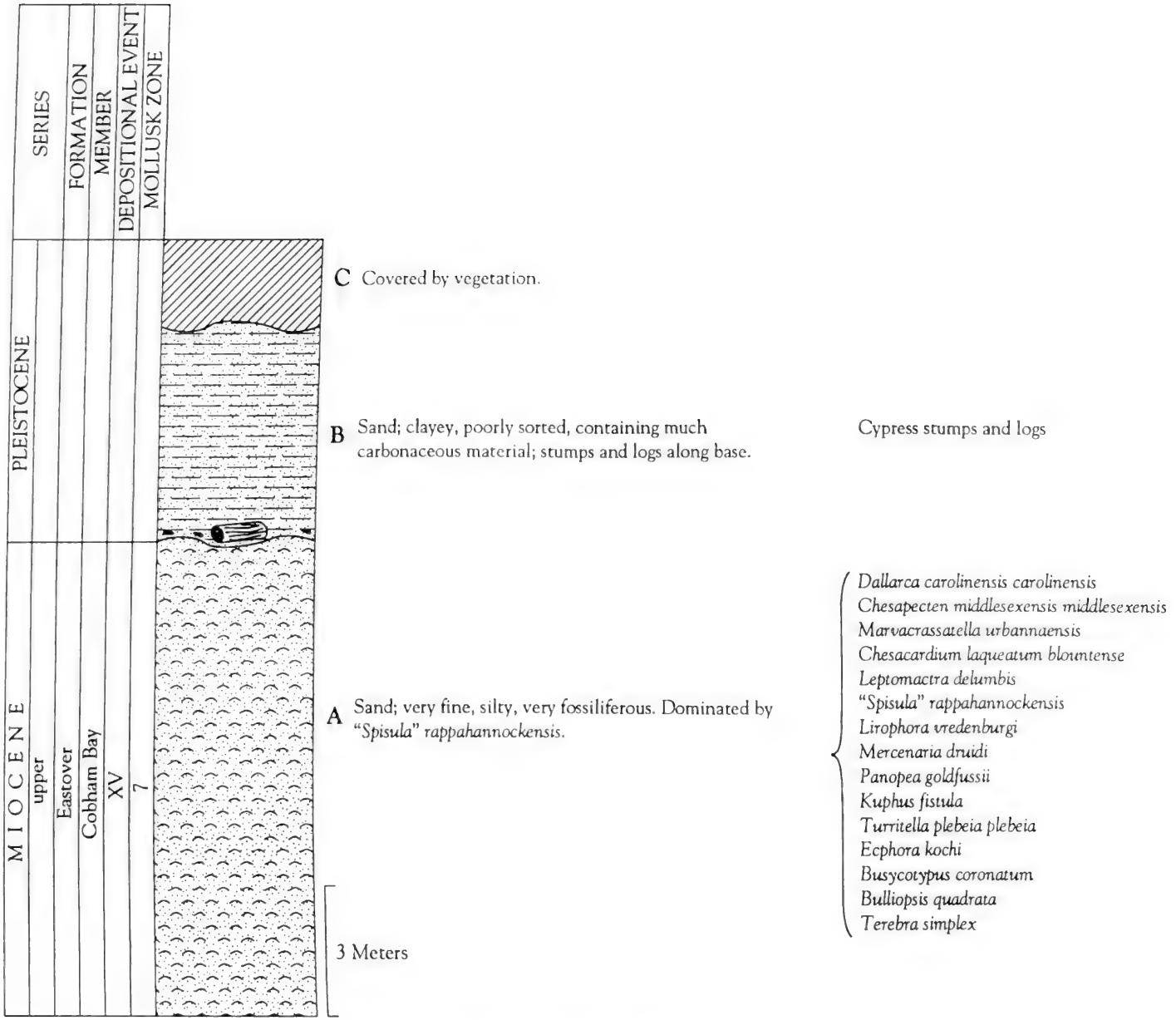


Figure 6.—Stratigraphic section 1.7 km below Bowlers Wharf, Essex County, Va. (Locality 2).

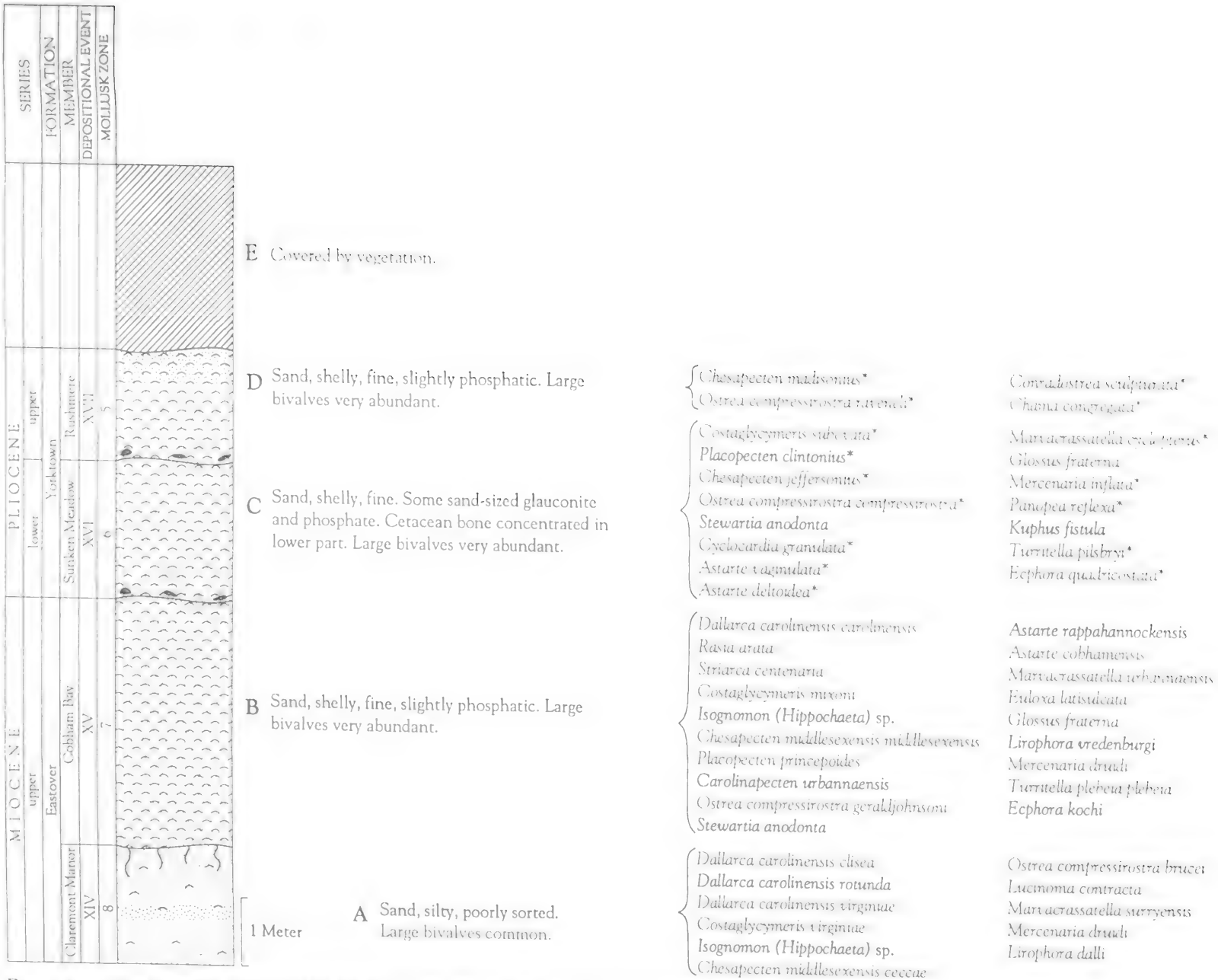


Figure 7.—Stratigraphic section 0.8 km below Cobham Wharf, Surry County, Va. (Locality 3). Asterisk (*) indicates mollusks not found in the Miocene and not figured or treated in the systematics.

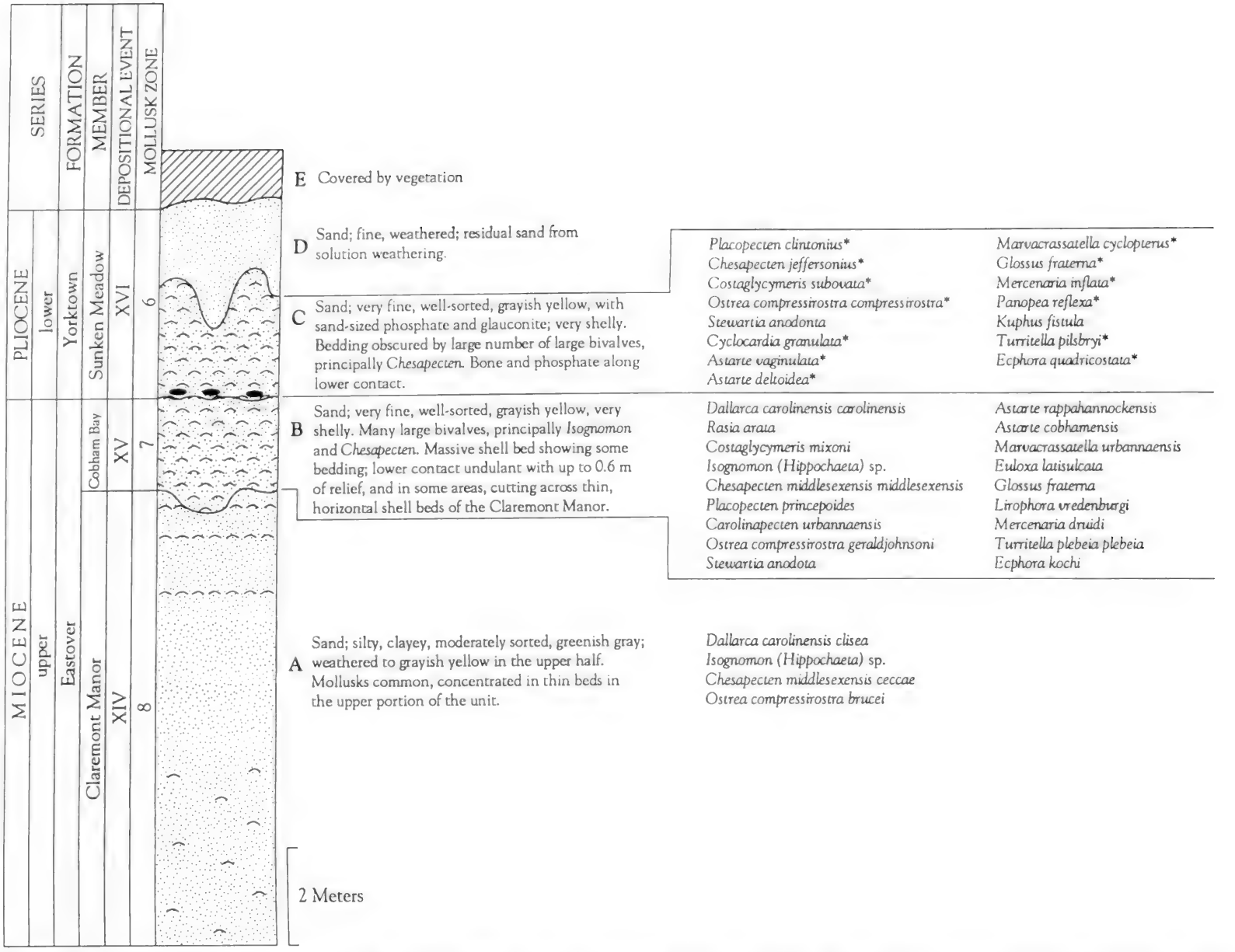


Figure 8.—Stratigraphic section above Mount Pleasant, Surry County, Va. (Locality 4). Asterisk (*) indicates mollusks not found in the Miocene and not figured or treated in the systematics.

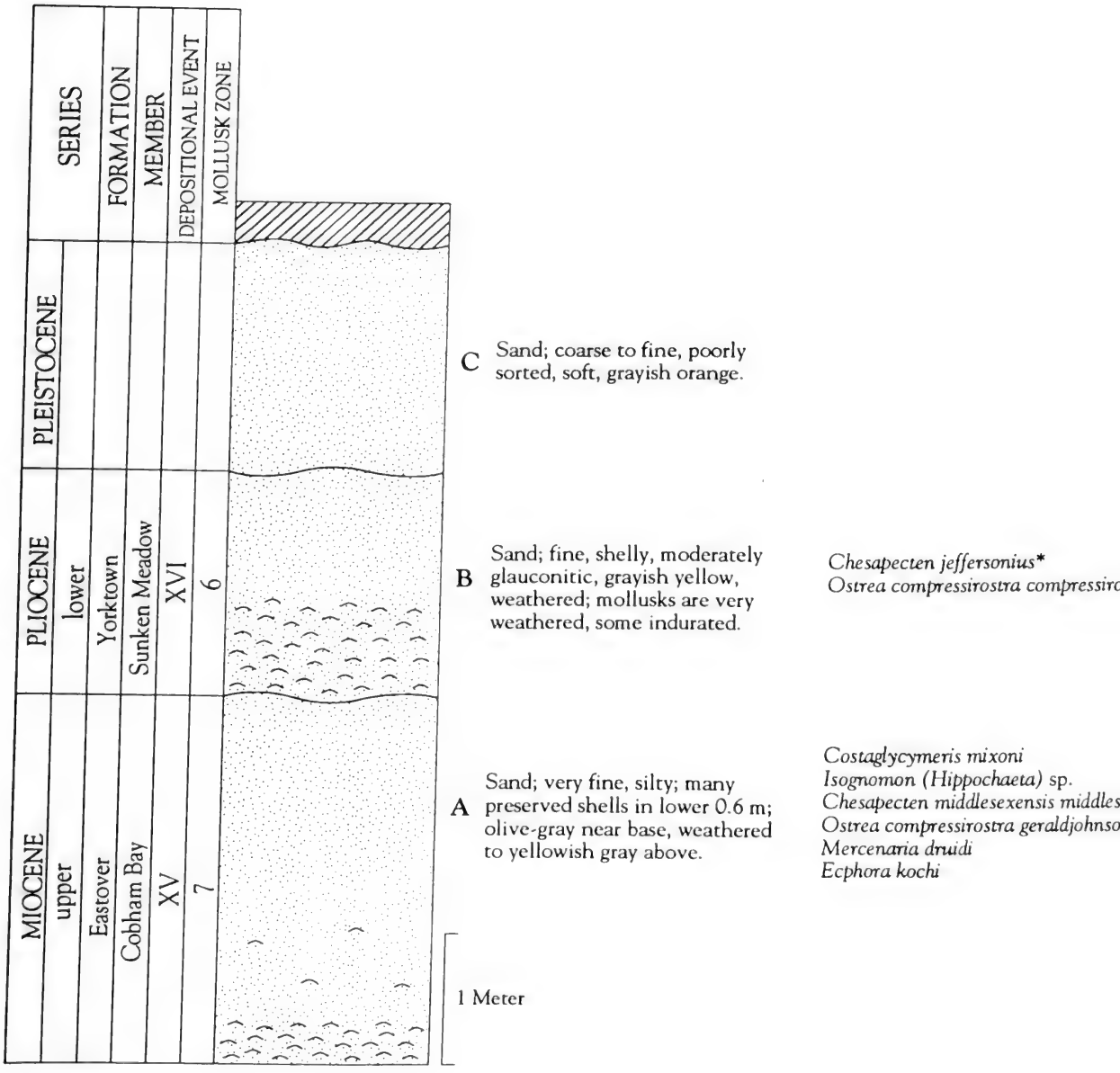


Figure 9.—Stratigraphic section above the mouth of Bush Park Creek, Middlesex County, Va. (Locality 5). Asterisk (*) indicates mollusks not found in the Miocene and not figured or treated in the systematics.

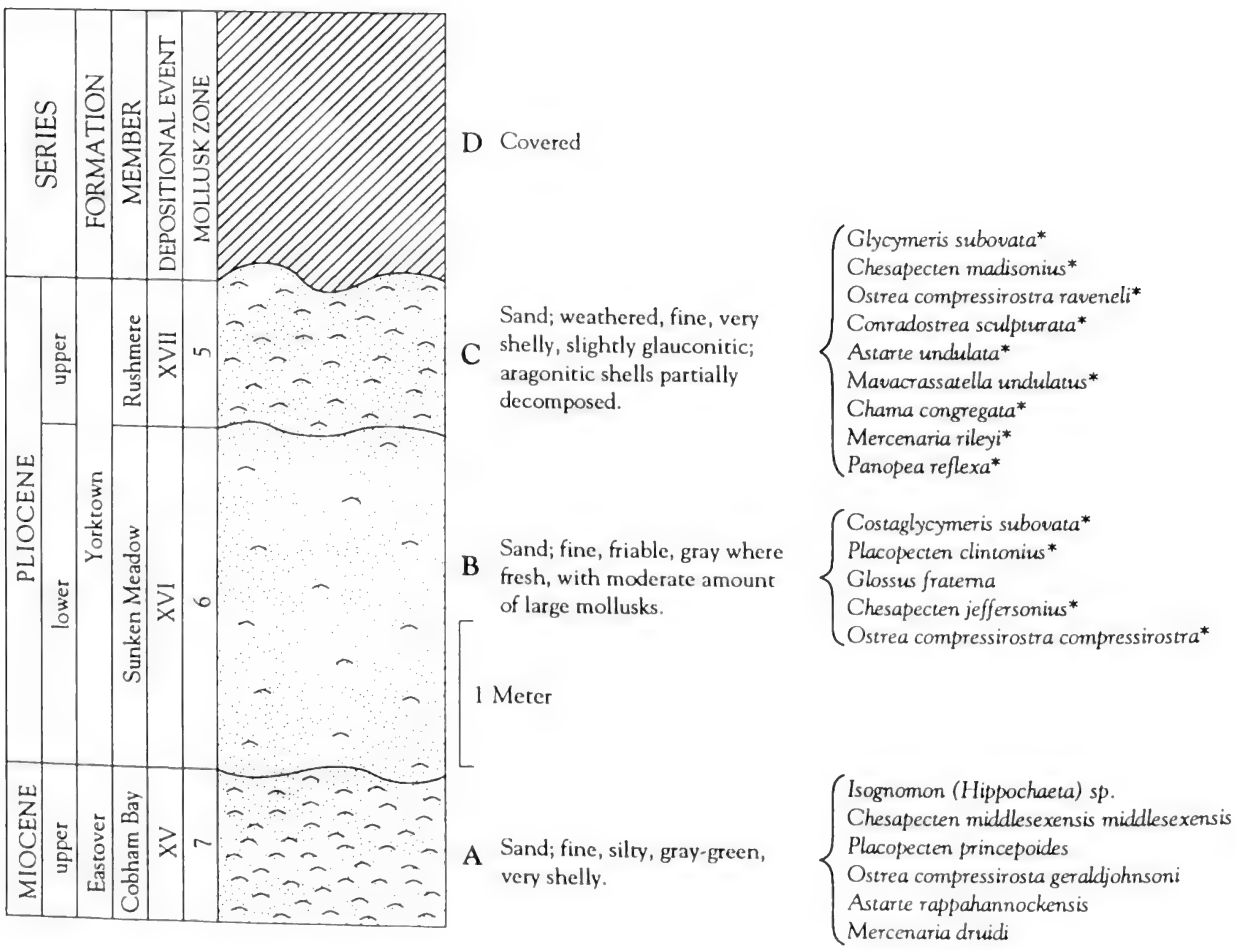


Figure 10.—Stratigraphic section north of the Murfreesboro town limits, Hertford County, N. C. (Locality 6). Asterisk (*) indicates mollusks not found in the Miocene and not figured or treated in the systematics.

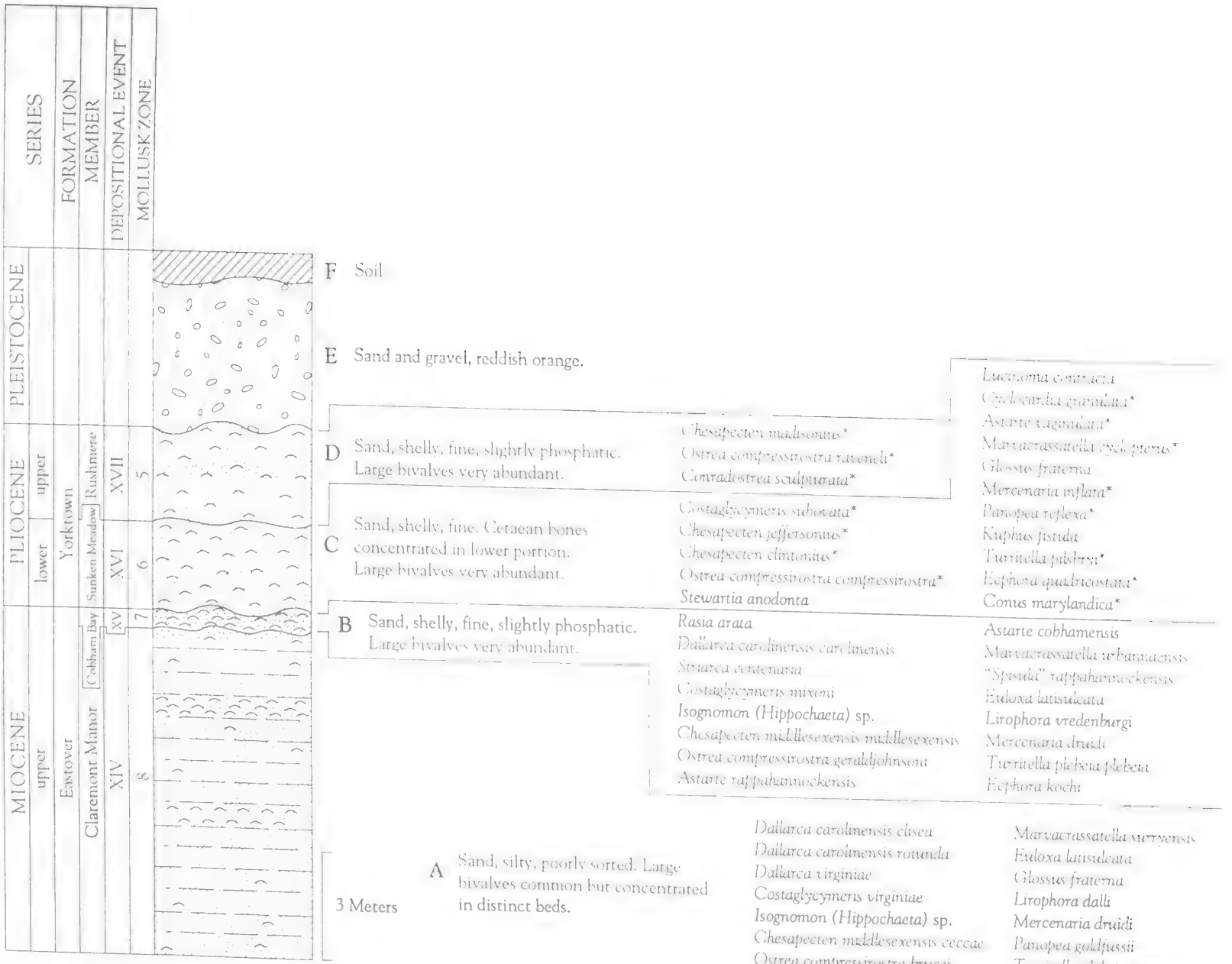
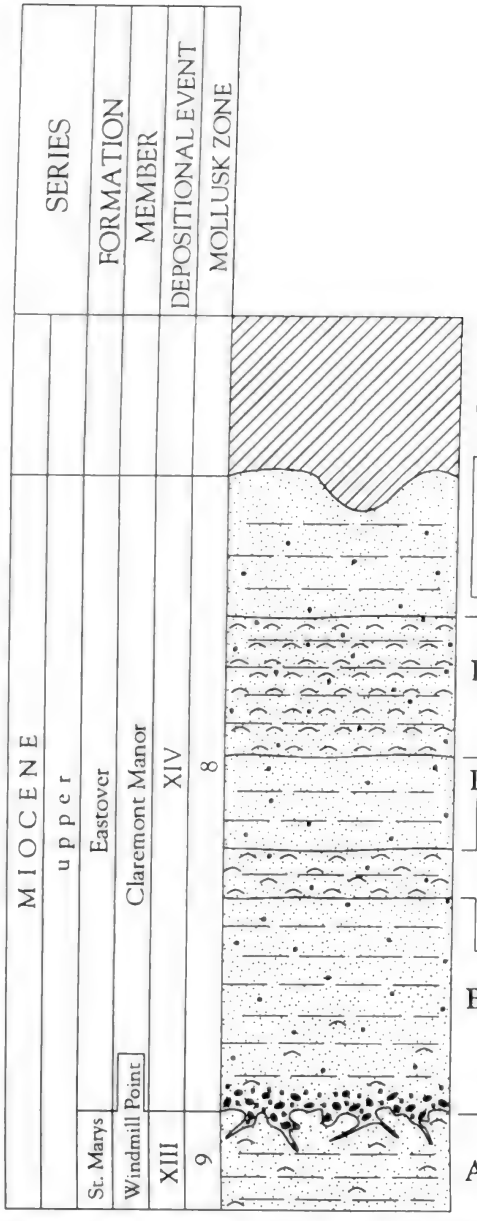


Figure 11.—Stratigraphic section 1.3 km below the mouth of Sunken Meadow Creek, right bank of the James River, Surry County, Va. (Locality 7). Asterisk (*) indicates mollusks not found in the Miocene and not figured or treated in the systematics.



G Covered by vegetation.

1 Meter

F Sand, silty, poorly-sorted. Few molds of bivalves. — Few molds

E Sand, shelly, silty, poorly sorted. Abundant poorly preserved bivalves, principally *Glossus fraterna* — *Glossus fraterna*, *Dosinia* sp., *Mercenaria* sp. prob. *druidi*

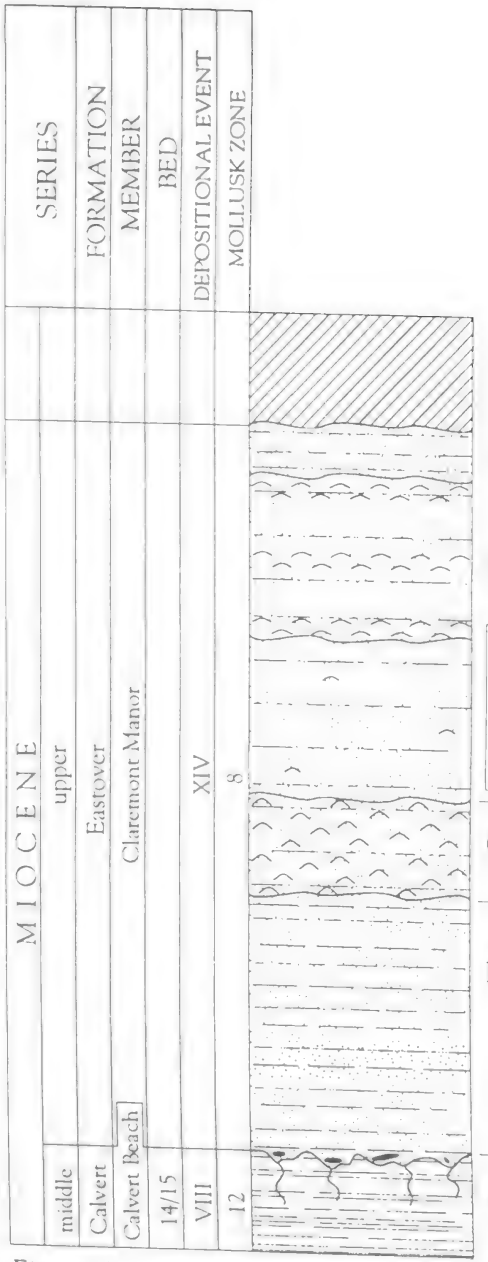
D Sand, silty, poorly sorted. Few molds of bivalves. — Few molds.

C Sand, shelly, silty, poorly sorted. Abundant poorly preserved bivalves, principally *Glossus fraterna* — *Chesapecten middlesexensis middlesexensis*, *Ostrea compressirostra brucei*, *Glossus fraterna*, *Mercenaria* sp. prob. *druidi*, *Ecphora gardnerae whiteoakensis*

B Sand, silty, poorly-sorted. Few poorly preserved bivalves. Cetacean bone, crab nodules, shark teeth, and phosphate nodules concentrated along lower contact. Burrows up to 0.5 m into underlying bed. — Few mollusk molds, crab nodules, shark teeth, fish teeth; whale bone, porpoise bone, seal bone

A Sand, shelly, silty, fine. Calcitic mollusks finely-preservd, aragonitic forms poorly preserved. — *Chesapecten santamaria*, *Astarte perplana*, *Glossus santamaria*; *Panopea goldfussii*, *Turritella plebeia plebeia*, *Ecphora gardnerae gardnerae*

Figure 12.—Stratigraphic section at White Oak Landing, right bank of the Mattaponi River, King William County, Va. (Locality 8).



G Covered with vegetation.

F Sand; fine, silty, greenish gray. — Few mollusk molds

E Sand; fine, silty, greenish gray; *Glossus* scattered throughout but concentrated in several distinct beds. — *Glossus fraterna*

1 Meter

D Sand; fine, silty, greenish gray. — Few mollusks, decomposed

C Sand; fine, silty, greenish gray, very shelly; shells partially decomposed and friable.

Chesapecten middlesexensis middlesexensis
Ostrea compressirostra bruceri
Glossus fraterna
Mercenaria sp. prob. *druidi*
Ecphora gardnerae whiteoakensis

B Sand; fine to coarse, silty, clayey, poorly sorted, greenish gray; coarse grains, pebbles, cobbles, bone, teeth, crab nodules concentrated in lower portion; grades to finer above; burrows extend deeply into underlying unit.

Few mollusk molds
crab nodules
shark teeth
fish teeth
whale bone
porpoise bone

A Silty, clayey, blocky, diatomaceous; coarse material from overlying unit fills burrows. Residual material from St. Marys Formation remains in some burrows, a relict of unit now removed. See Bed A at White Oak Landing where this bed is preserved (Fig. 12, loc. 8).

No mollusks. The same bed slightly upriver at Horse Landing contained the following stratigraphically significant diatoms:

Actinoptychus virginicus
Delphineis angustata
Delphineis novaecaesaraea
Delphineis penelliptica
Denticulopsis hustedtii
Rhaphoneis gemmifera

They indicate East Coast Diatom Zone 5 and equivalence to Bed 15 (G. W. Andrews, written commun., 1982).

Figure 13.—Stratigraphic section Rickahock, King and Queen County, Va. (Locality 9)

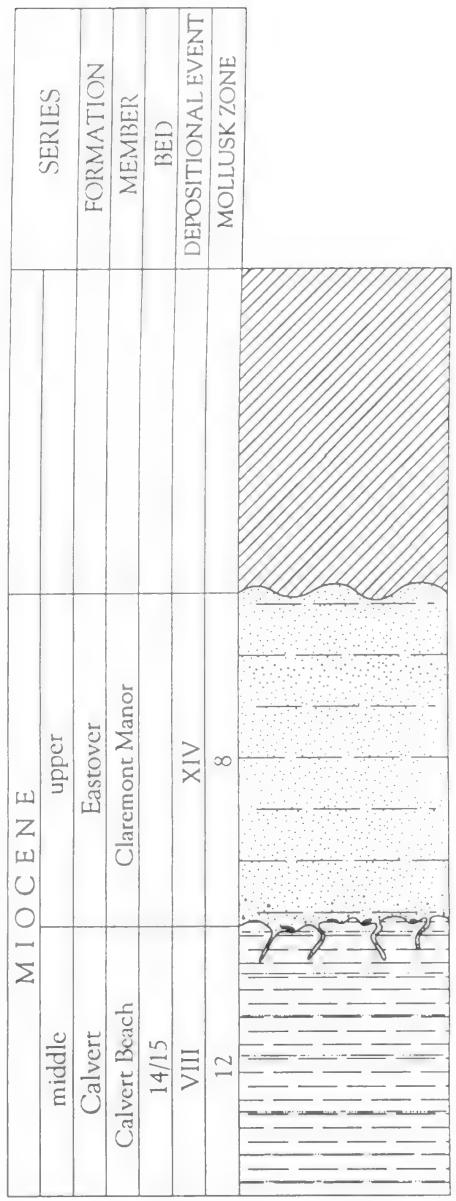


Figure 14.—Stratigraphic section at Elsing Green, King William County, Va. (Locality 10).

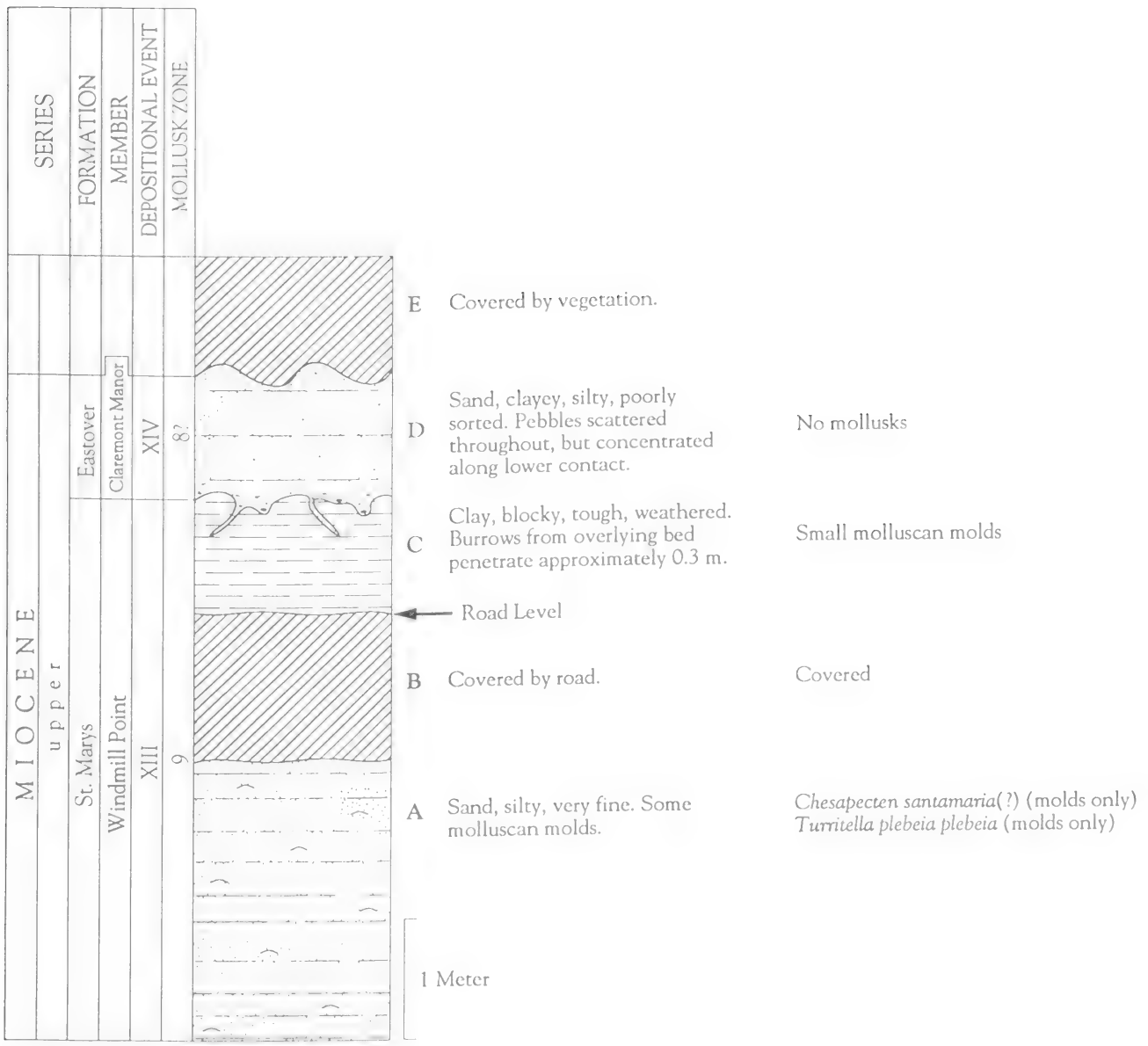


Figure 15.—Stratigraphic section at Mt. Airy Millpond and Rte. 621, Richmond County, Va. (Locality 11).

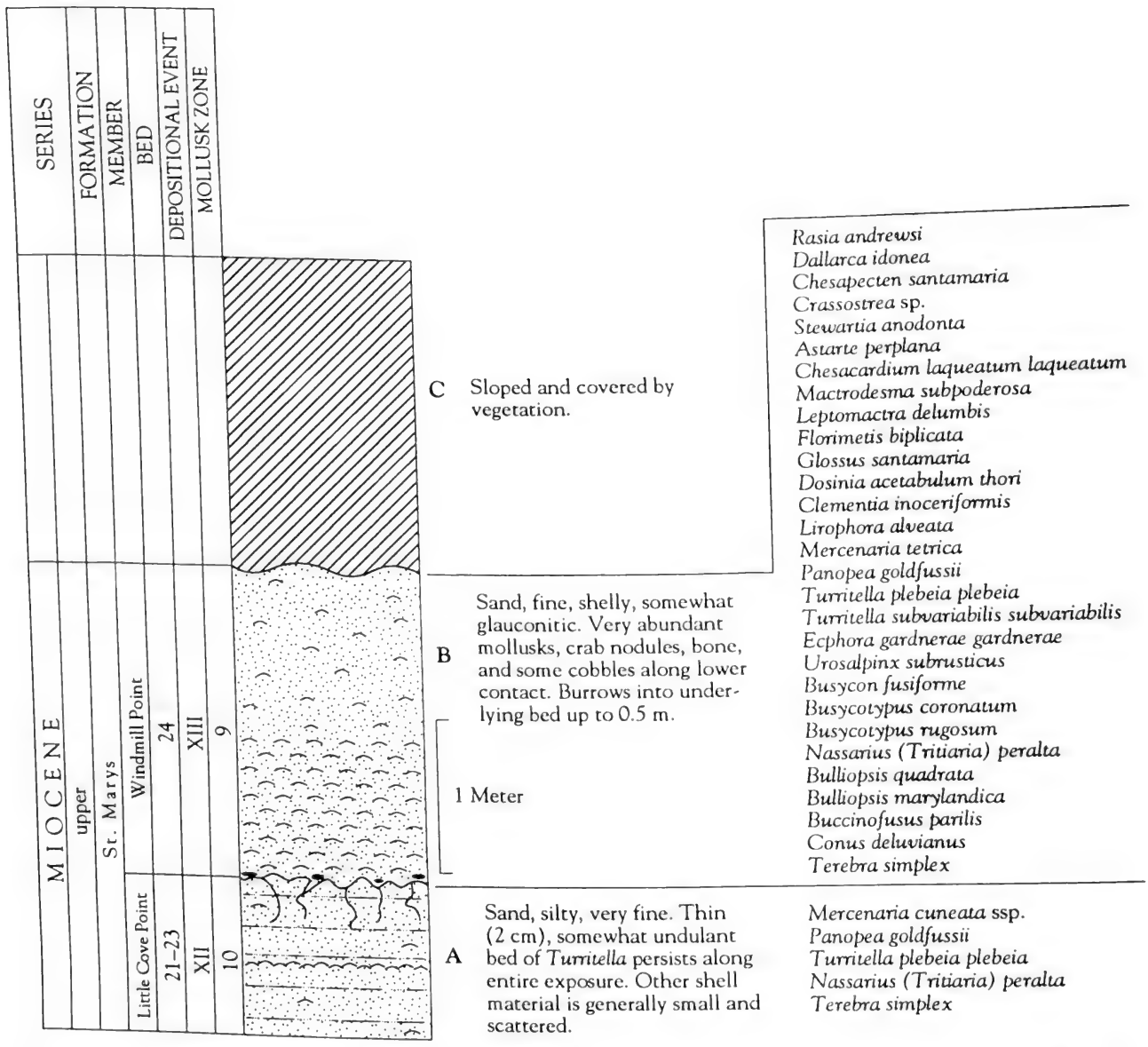
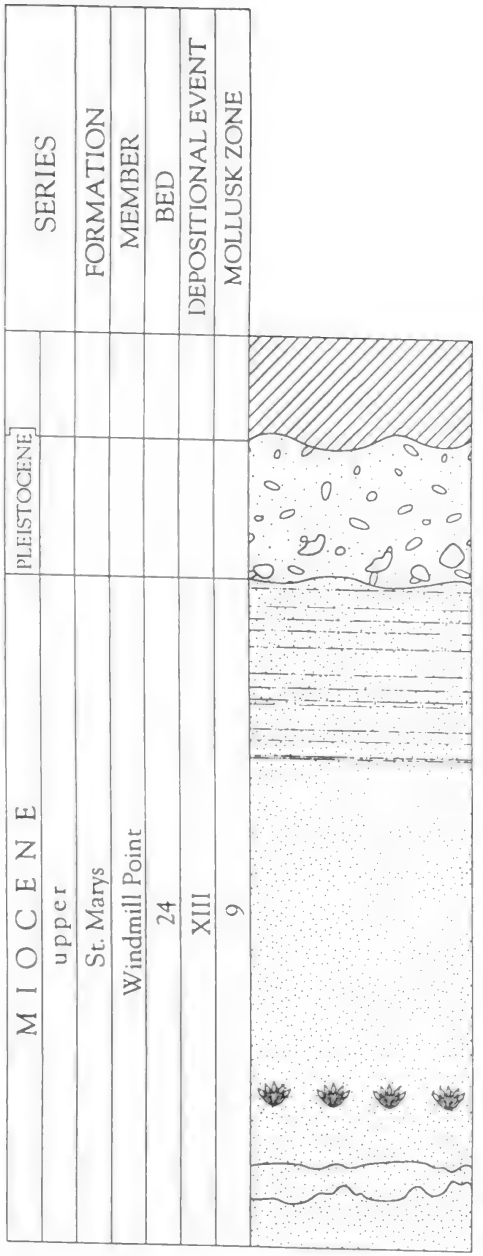


Figure 16.—Stratigraphic section 1.0 km above Windmill Point on the right bank of the St. Marys River, St. Marys County, Md. (Locality 12).



E Covered.

D Sand; coarse with pebbles and few cobbles, orange. — No fossils

1 Meter

C Sand; very fine, clayey, silty, dark olive-gray, becoming increasingly silty and clayey above with a laminated appearance. Gypsum crystals common in the lower 0.6 meters. Some molds and casts, mollusks leached. — Few molds of small mollusks

B Sandstone; indurated, fine, very shelly, dark olive-gray. Many poorly preserved, water-worn mollusks concentrated along this horizon. Bed is cemented producing a ledge that projects and is undercut up to 0.9 meters. — Same taxa as Bed A but worn and concentrated along a 0.3–0.6 m horizon, which has become lithified, probably from the concentration of calcitic mollusks principally *Chesapecten*.

A Sand, very fine, silty, dark olive-gray, with mollusks well-preserved and concentrated in pockets on thin beds. *Turritella plebeia plebeia* especially abundant. — *Rasia andrewsi*, *Dallarca idonea*, *Isognomon (Hippochaeta)* sp., *Chesapecten santamaria*

Crassostrea sp.
Stewartia anodonta
Astarte perplana
Chesacardium laqueatum laqueatum
Mactrodesma subponderosa
Leptomactra delumbis
Florimetis biplicata
Glossus santamaria
Dosinia acetabulum thori
Clementia inoceriformis
Lirophora alveata
Mercenaria tetrica
Panopea goldfussii
Turritella plebeia plebeia
Turritella subvariabilis subvariabilis
Ecphora gardnerae gardnerae
Urosalpinx subrusticus
Busycon fusiforme
Busycotypus coronatum
Busycotypus rugosum
Nassarius (Tritiaria) peralta
Bulliopsis quadrata
Bulliopsis marylandica
Buccinofusus parilis
Conus deluvianus
Terebra simplex

Figure 17.—Stratigraphic section below Chancellor Point, St. Marys County, Md. (Locality 13).

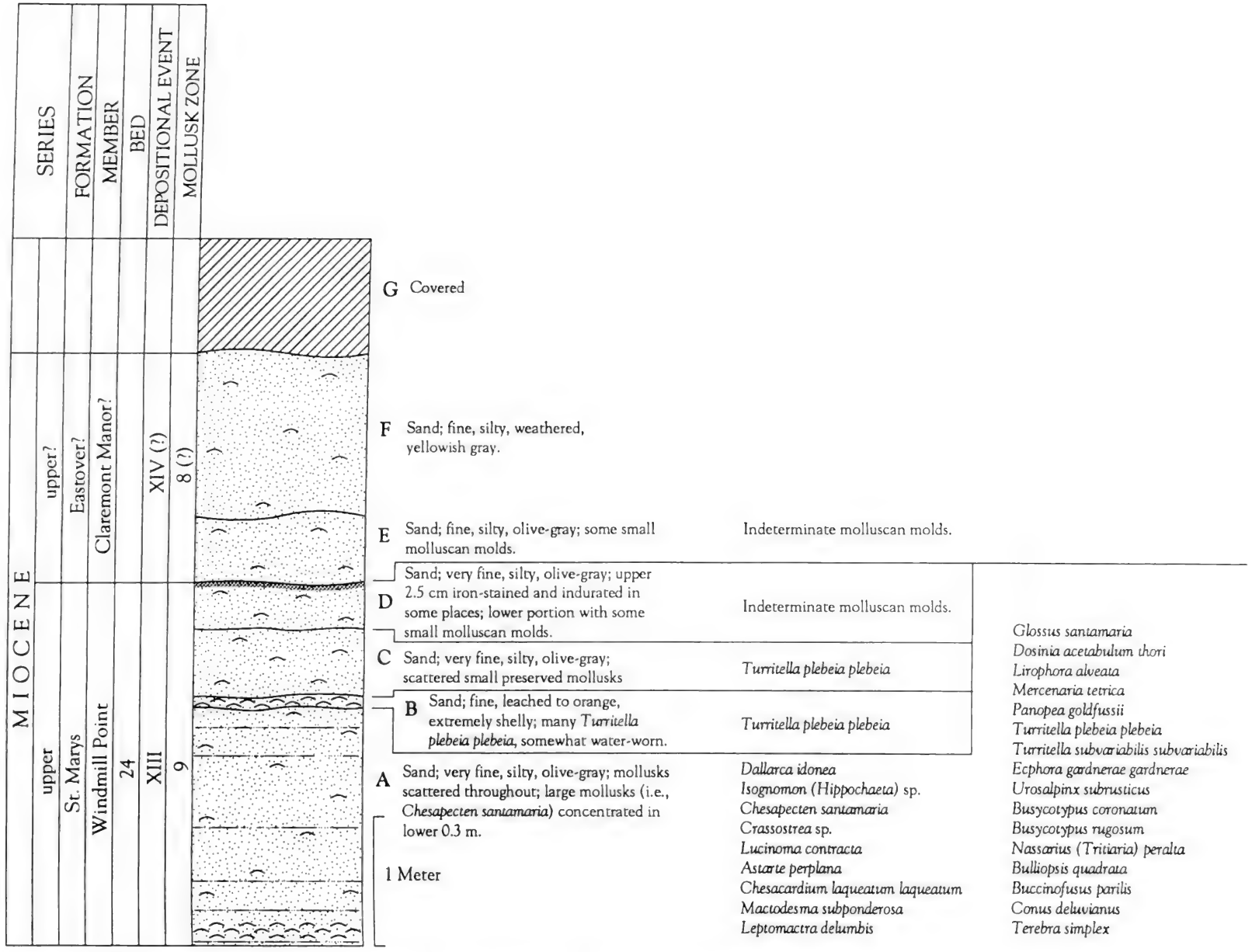


Figure 18.—Stratigraphic section at Essex Mill, 2.2 km west of Dunnsville, Essex County, Va. (Locality 14).

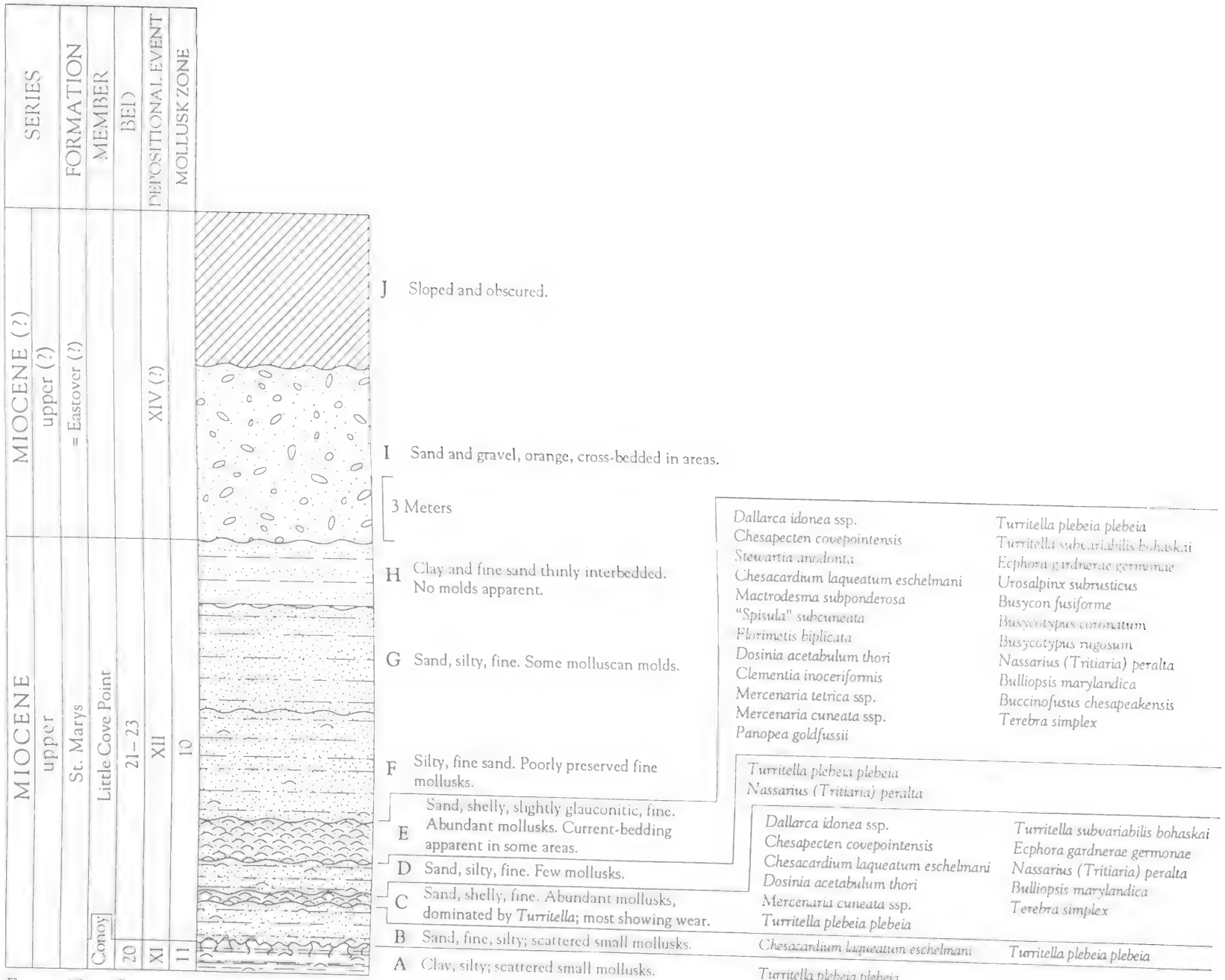


Figure 19.—Stratigraphic section 1.0 km below Little Cove Point, western shore of the Chesapeake Bay, Calvert County, Md. (Locality 15).

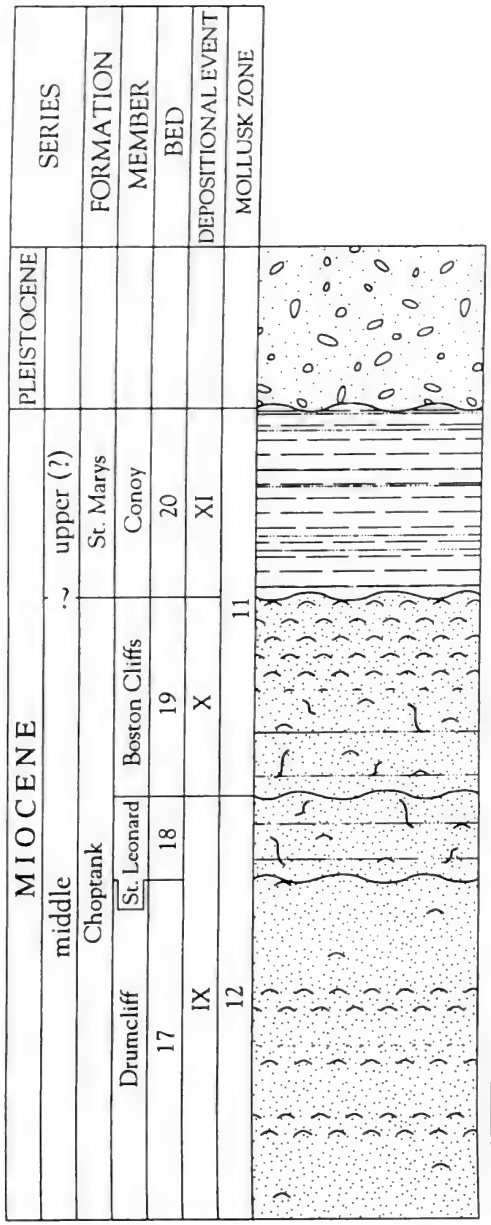


Figure 20.—Stratigraphic section at Drumcliff (Jones Wharf in old literature), 1.0 km above mouth of Saint Thomas Creek, right bank of the Patuxent River, St. Marys County, Md. (Locality 16).

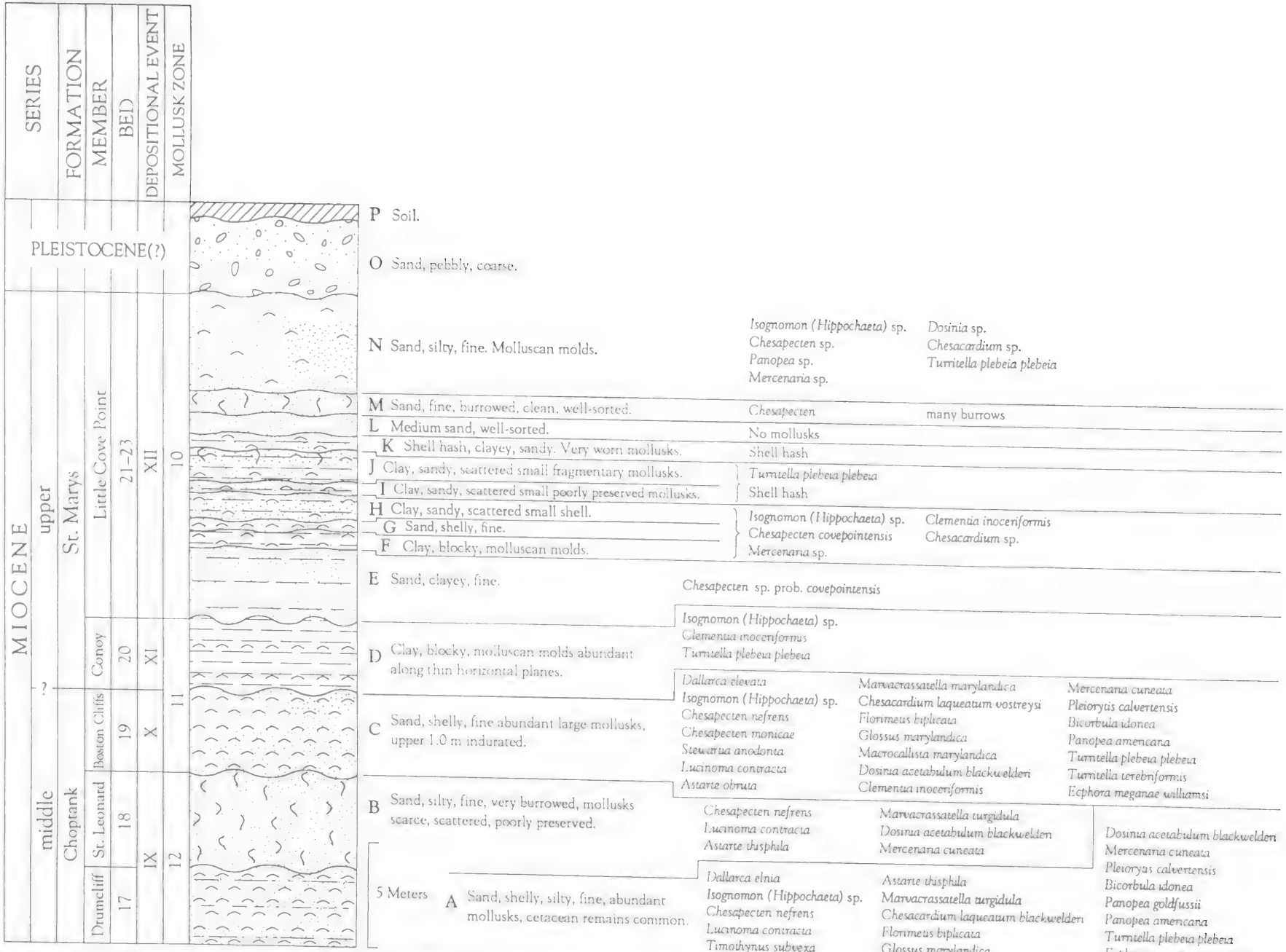


Figure 21.—Stratigraphic section 1.8 km below Flag Pond and just above the Baltimore Gas and Electric power station, western bank of the Chesapeake Bay, Calvert County, Md. (Locality 17).

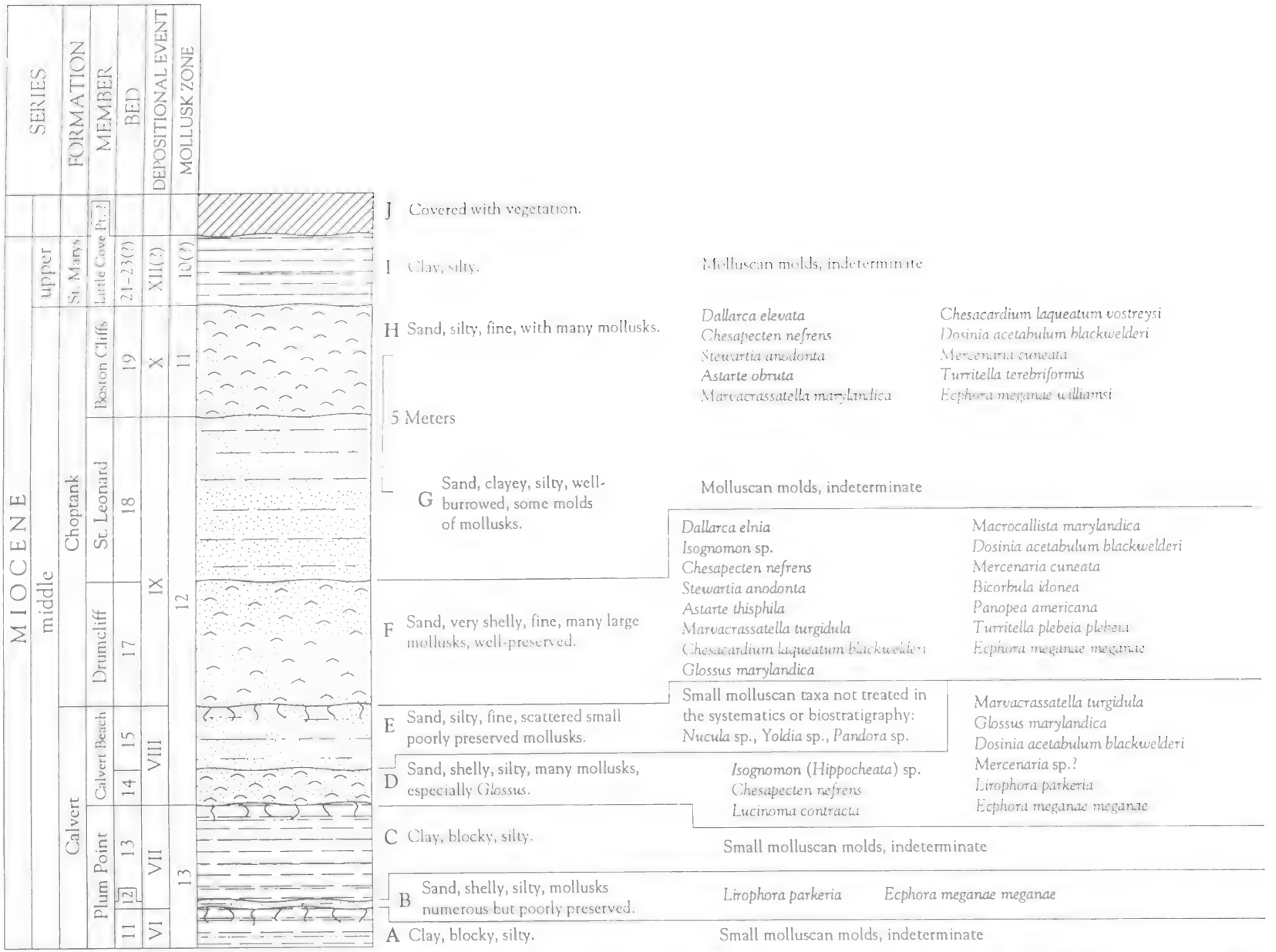


Figure 22.—Stratigraphic section 1.0 km below the mouth of Parker Creek, western bank of the Chesapeake Bay, Calvert County, Md. (Locality 18).

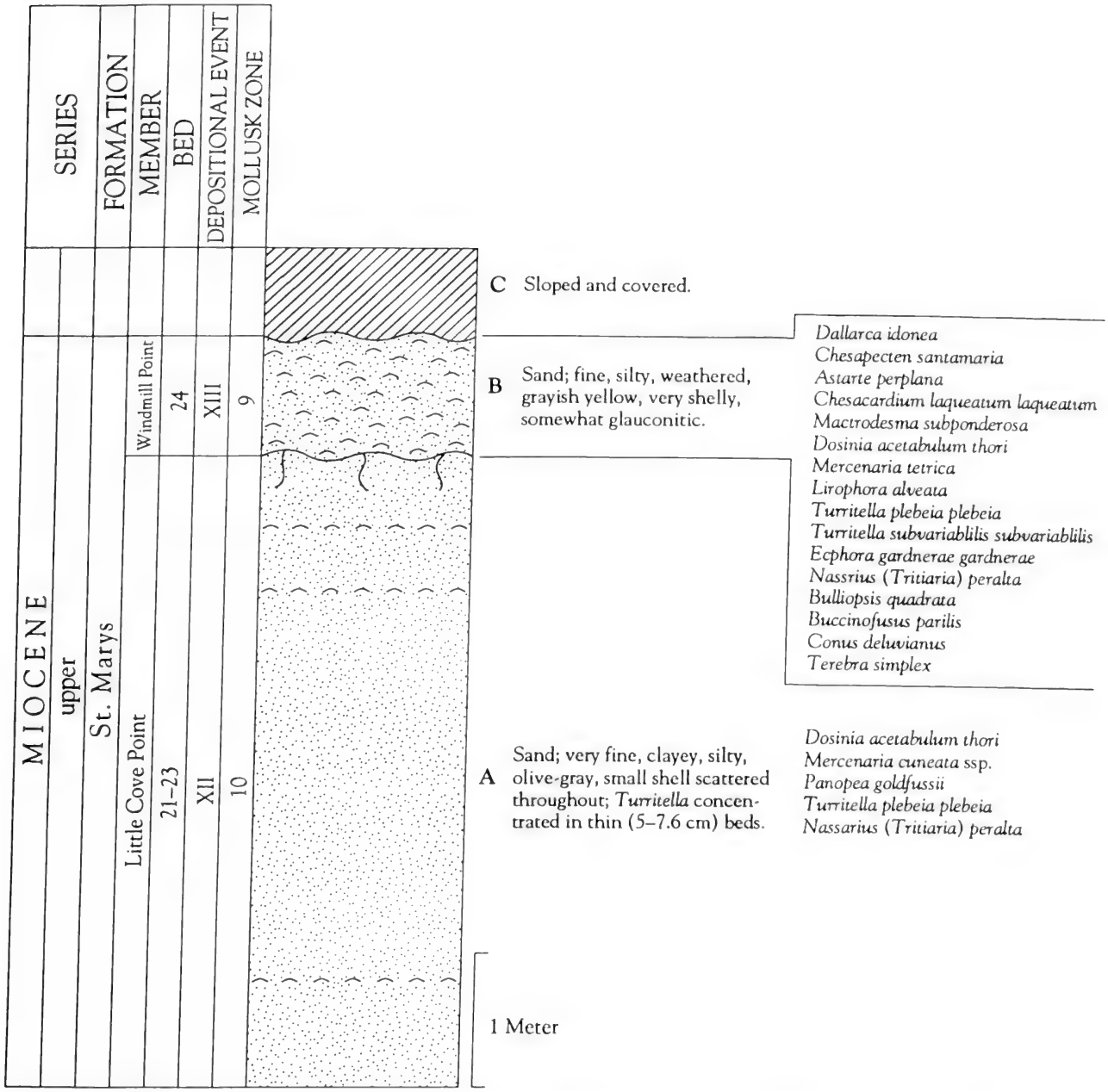


Figure 23.—Stratigraphic section 0.72 km above Portobello Point, at Orchard Point, St. Marys County, Md. (Locality 19).

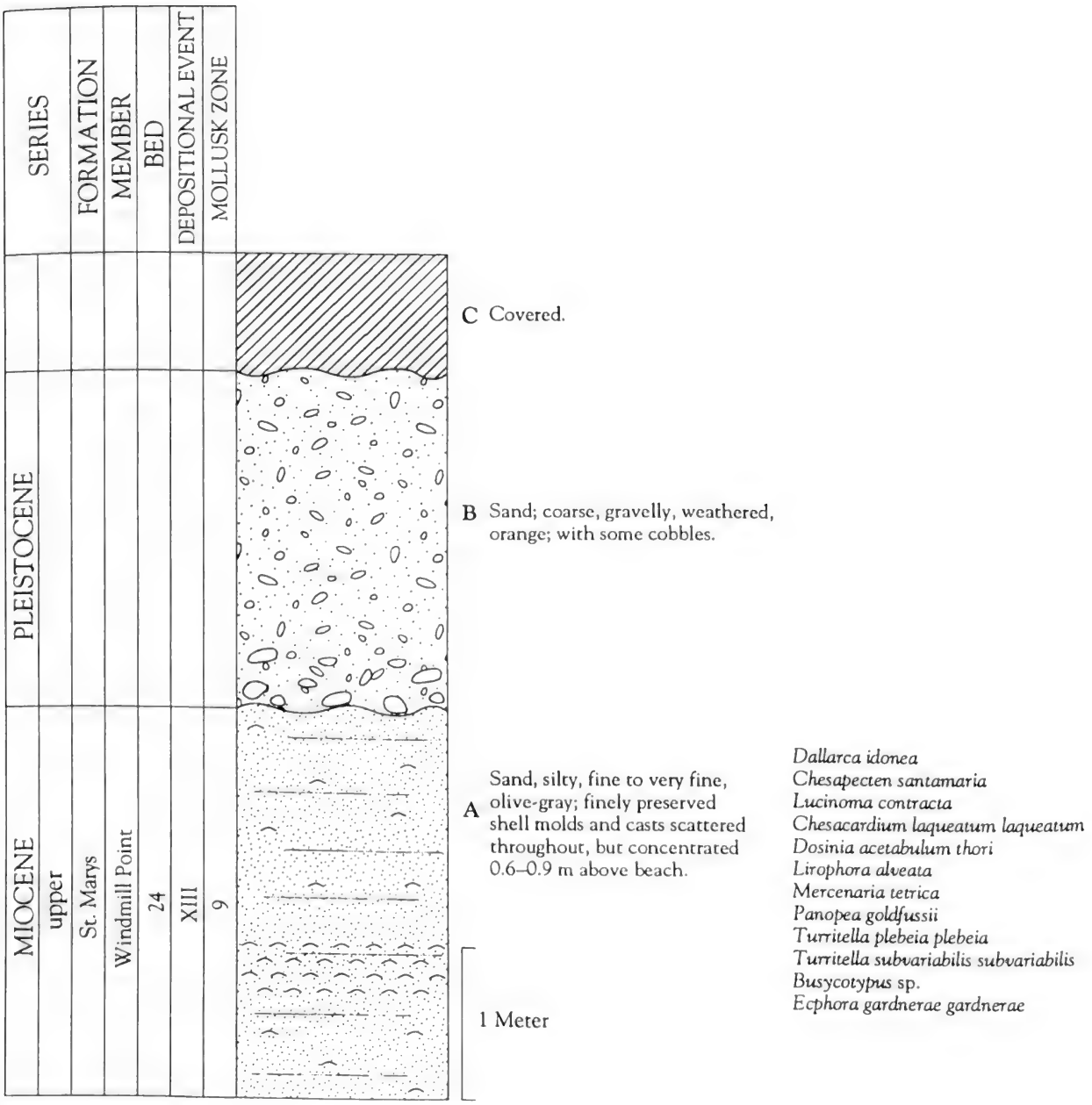


Figure 24.—Stratigraphic section above Islington Landing, 1.0 km below the mouth of Little Carter Creek, Richmond County, Va. (Locality 20).

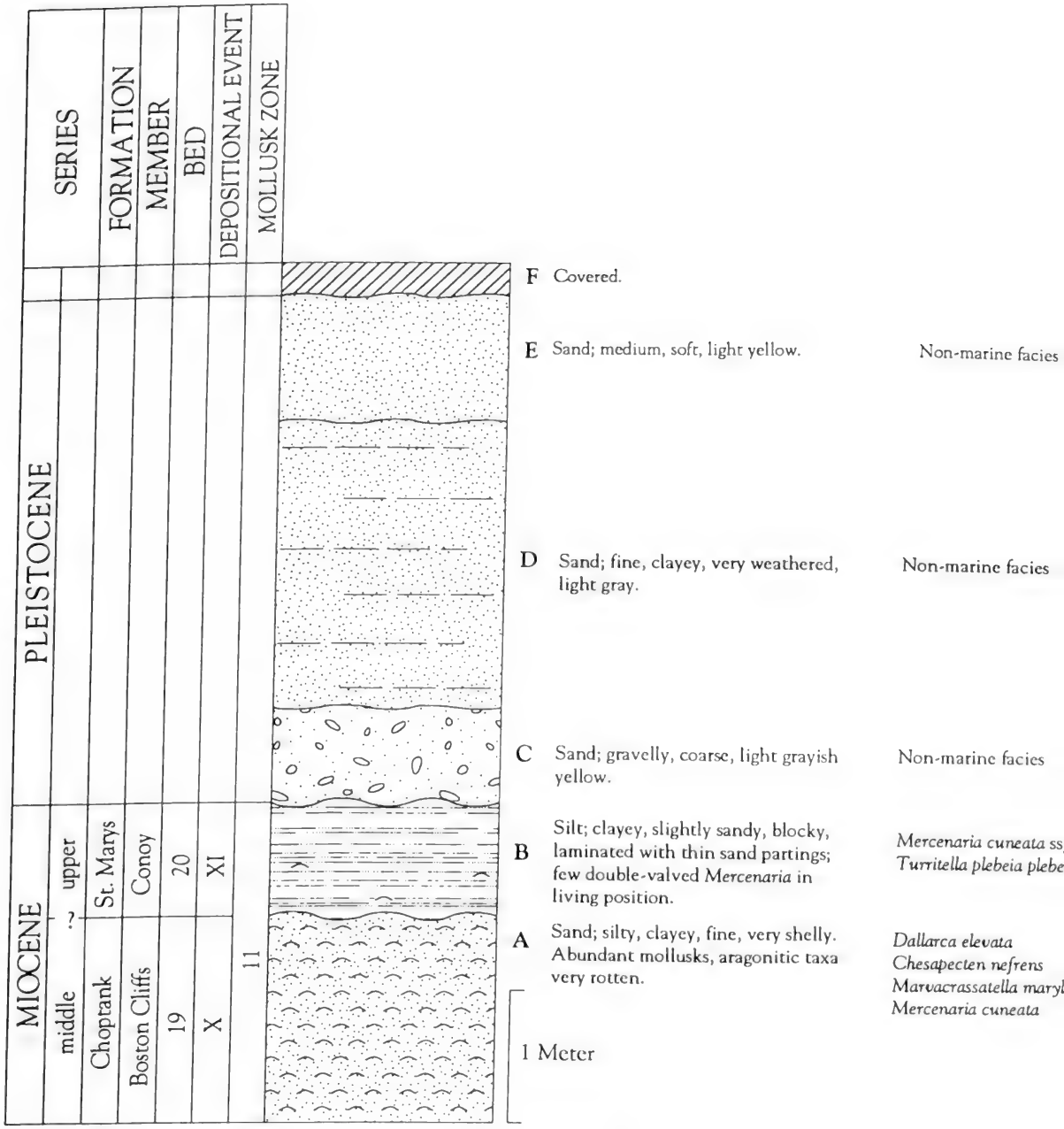
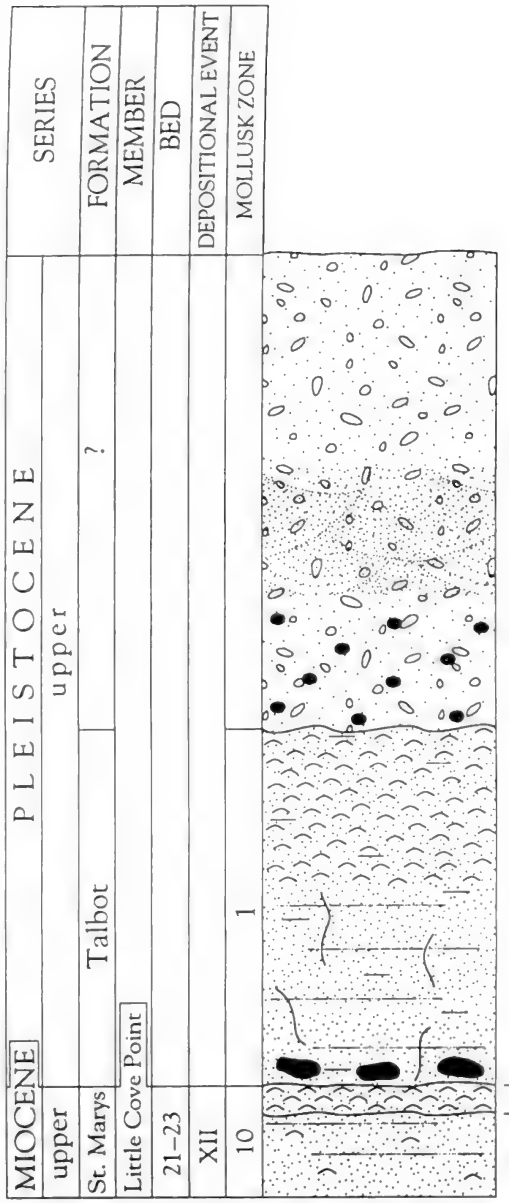


Figure 25.—Stratigraphic section above the mouth of Hellen Creek, Calvert County, Md. (Locality 21).



D Sand; coarse, gravelly, weathered, soft, grayish yellow.

1 Meter

C Sand; silty, clayey, very fine; *Mulinia lateralis* is concentrated in large numbers in upper 1.2 m and in deep burrows in lower 1.2 m. Layer of cobbles along base of bed.

*Anadara transversa** *Mulinia lateralis**
*Crassostrea virginica** *Cyrtopleura costata**

The mollusks in this bed are not included in this study. For a complete listing of mollusks see Mansfield (1928b) and Blake (1953).

B Shell hash; sandy; contains a concentration of worn shell material; some contamination of *Mulinia* from above bed, probably through burrowing.

Dallarca idonea ssp. *Mercenaria cuneata* ssp.
Chesapecten covepointensis *Panopea goldfussii*
Chesacardium sp. *Turritella plebeia plebeia*
"Spisula" subcuneata *Busycotypus coronatum*
Dosinia acetabulum thori *Busycotypus rugosum*

Dallarca idonea ssp. *Mactrodesma subponderosa* *Turritella plebeia plebeia*
Chesapecten covepointensis *Dosinia acetabulum thori* *Busycotypus coronatum*
Stewartia anodonta *Clementia inoceriformis* *Busycotypus rugosum*
Lucinoma contracta *Mercenaria cuneata* ssp. *Nassarius (Tritiaria) peralta*
Marvacrassatella sp. *Panopea goldfussii* *Terebra simplex*
Chesacardium laqueatum eschelmani

A Sand, silty, fine, olive-gray; excellently preserved mollusks common.

Figure 26.—Stratigraphic section at Langleys Bluff (of old literature) 7.3 km below Cedar Point, 1.0 km below the mouth of Beaver Dam Creek, St. Marys County, Md. (Locality 22). Asterisk (*) indicates mollusks not found in the Miocene and not figured or treated in the systematics.

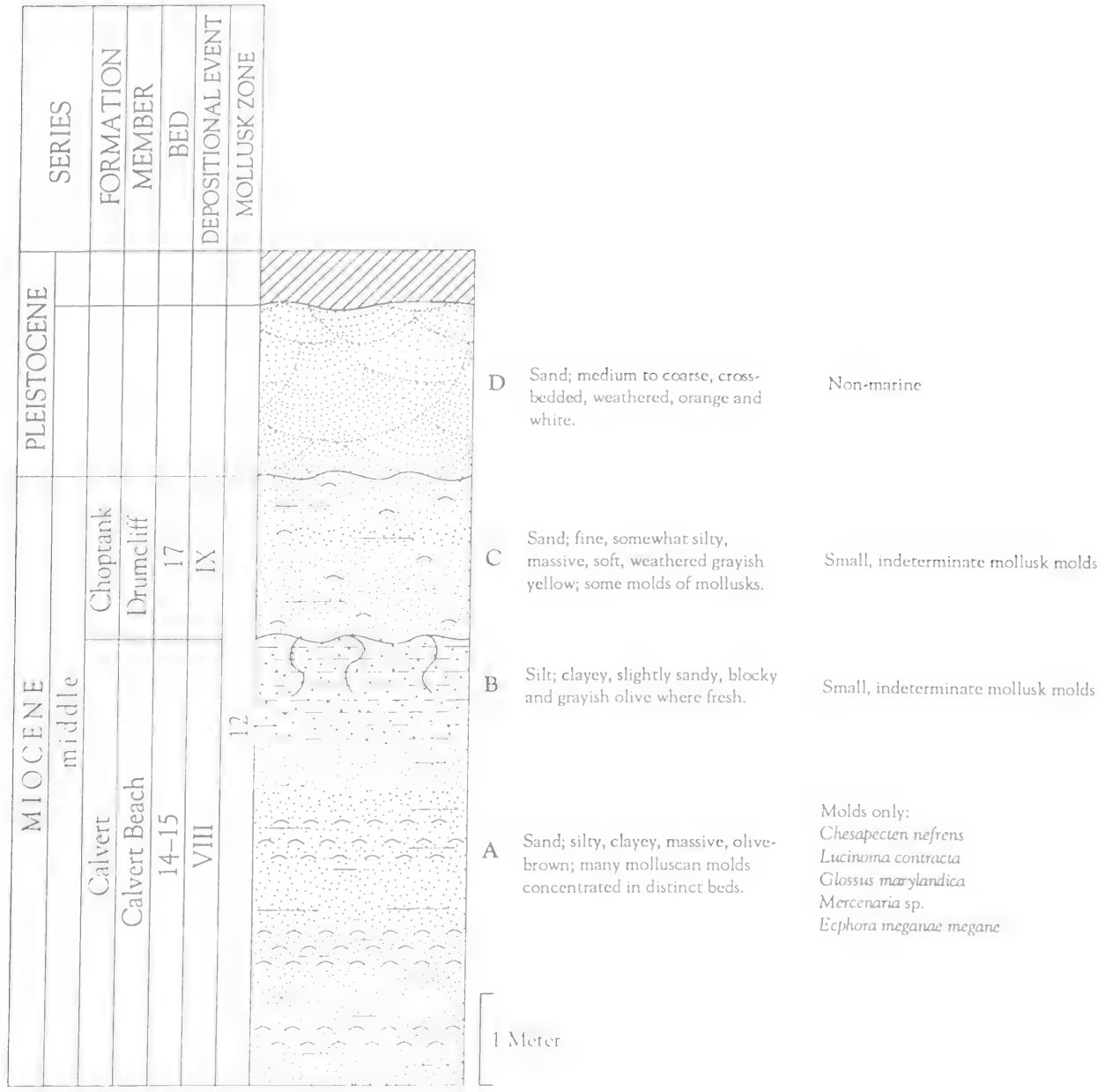
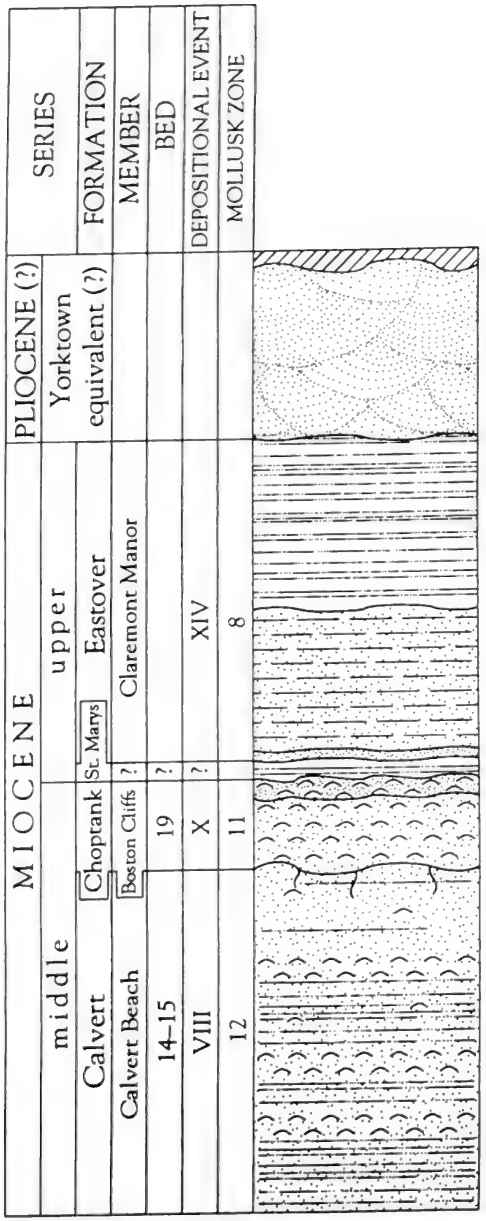


Figure 27.—Stratigraphic section at Queen Tree Landing, just above the mouth of Cat Creek, St. Marys County, Md. (Locality 23).



F Sand; medium to coarse, cross-bedded, oxidized, orange; iron-cemented locally.

E Silt; clayey, slightly sandy, olive-gray; sand is concentrated along thin beds forming partings and giving a laminated appearance.

"Spisula" rappahannockensis (molds only)

D Sand; silty, clayey, massive, olive-gray.

Molds only - poor, indeterminate

C Silt; sandy, clayey, olive-gray; unit has a thin irregularly indurated caprock.

No molds of mollusks

B Sand; fine, soft, very shelly, somewhat weathered, grayish yellow; lower 1.8 m is friable, upper 0.6 m is indurated and forms a deeply undercut ledge.

Dallarca elevata
Chesapecten nefrens
Stewartia anodonta
Astarte obruta
Marvacrassatella marylandica
Chesacardium sp.
Dosinia acetabulum blackwelderi
Mercenaria cuneata

A Sand; silty, clayey, olive-brown. Alternating thin beds of silty sand and clayey silt; thin beds of poorly preserved mollusks along the sandy horizons.

Taxa are in poor condition due to weathering:
Isognomon (*Hippochaeta*) sp.
Chesapecten nefrens
Lucinoma contracta
Glossus marylandica
Mercenaria cuneata
Turritella plebeia plebeia

Figure 28.—Stratigraphic section 3.2 km above Haulover Inlet, Westmoreland County, Va. (Locality 24).

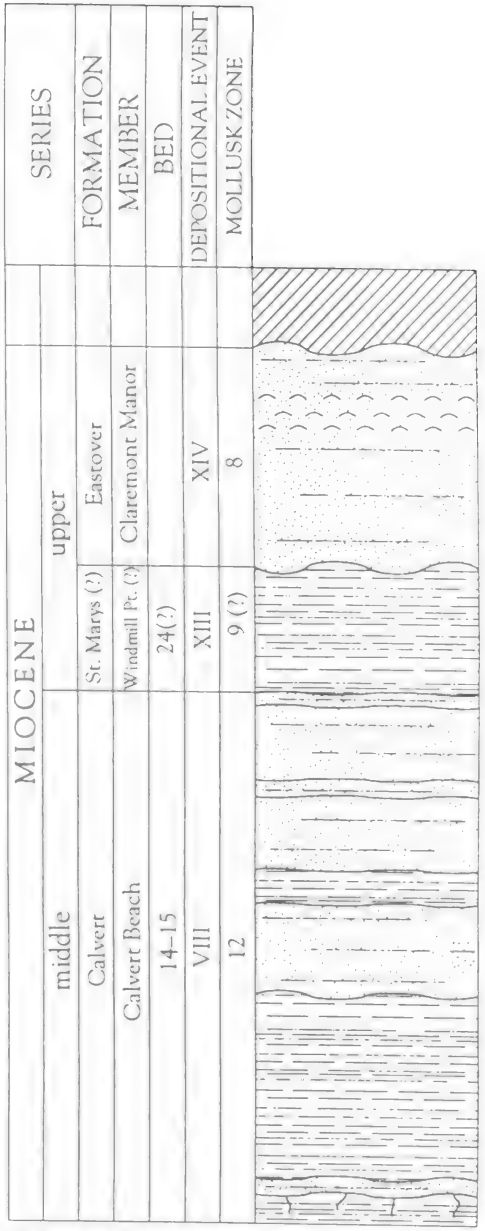
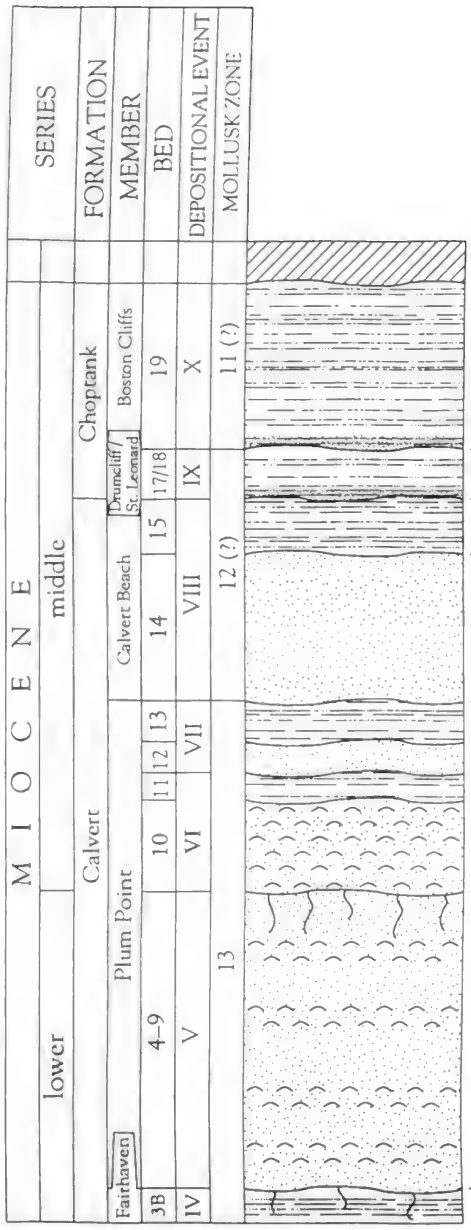


Figure 29.—Stratigraphic section 3.54 km below Carters Wharf, just above Smoots Landing, Richmond County, Va. (Locality 25).



K Soil.

J Silt, sandy at base, becoming clayey and blocky above. — No mollusks observed.

I Silt, sandy at base, becoming clayey and blocky above. — No mollusks observed.

H Clay, silty, blocky, weathered, yellowish gray. — No mollusks observed.

G Sand, shelly, silty, very fine, weathered, light olive-brown, shells poorly preserved but numerous.

Chesapecten nefrens
Lucinoma contracta
Astarte sp. indet.
Glossus marylandica
Lirophora parkeria
Ecphora meganae meganae

No mollusks observed.

F Clay, silty, blocky when weathered, olive-brown.

E Sand, shelly, silty, shells poorly preserved, olive-brown.

Chesapecten sp. indet.
Lirophora parkeria
Ecphora sp. indet.

D Clay, silty, blocky when weathered, olive-brown. — Small indeterminate mollusk molds

C Sand, very shelly, fine, yellowish gray, mollusks well-preserved, diverse, and abundant.

Dallarca subrostrata
Glycymeris parilis
Isognomon (Hippochaeta) sp.
Eburneopecten cerinus
Pecten humphreysii
Chesapecten coccymeus
Pycnodonte percrassa
Hyotissa haitensis
Stewartia anodonta
Stewartia foremani
Lucinoma contracta
Timothynus subvexa
Astarte cuneiformis
Marvacrassatella melina
Chesacardium crateuloides
Glossus markoei
Glossus mazlea
Melosia staminea
Macrocallista marylandica
Dosinia acetabulum blackwelderi
Mercenaria blakei
Bicorbula idonea
Varicorbula elevata
Panopea goldfussii
Panopea americana
Panopea whitfieldi
Turritella plebeia plebeia
Turritella exaltata
Turritella indenta
Ecphora tricostata pamlico
Ecphora tricostata tricostata

2 Meters

B Sand, silty, clayey, very fine, olive-brown, *Varicorbula elevata* numerous, concentrated in beds. A 0.5 m thick bed of oysters (*Pycnodonte percrassa*) concentrated just above the lower contact.

Pecten humphreysii
Chesapecten coccymelus
Pycnodonte percrassa
Lucinoma contracta
Varicorbula elevata

A Clay, blocky, slightly silty, grayish olive, very diatomaceous. — Small indeterminate mollusks

Figure 30.—Randle Cliff, 0.7 km north of Randle Cliff Beach, western shore of the Chesapeake Bay, Calvert County, Md. (Locality 26).

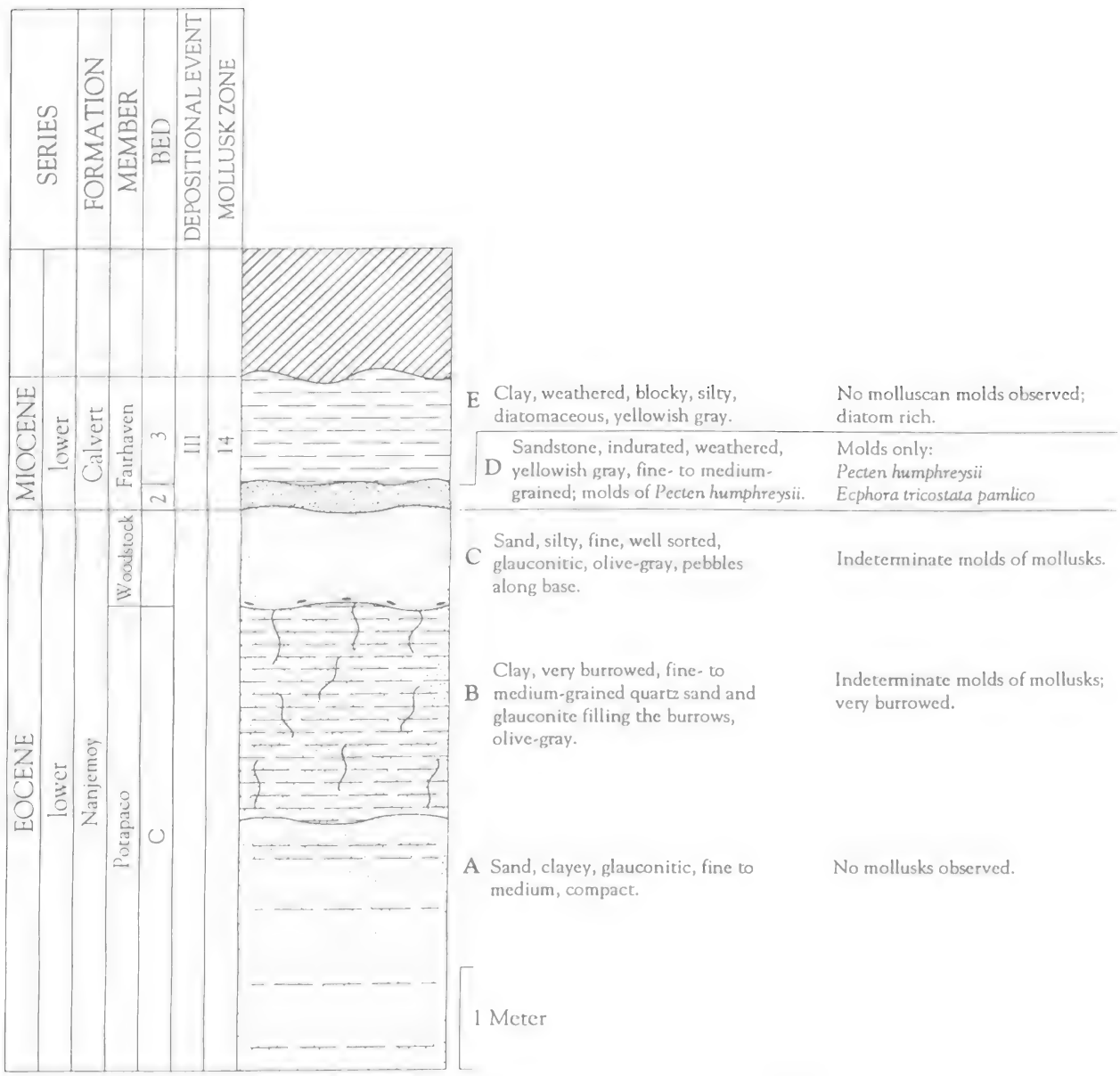


Figure 31.—Left bank of the Patuxent River, 0.4 km above Jones Point, Calvert County, Md. (Locality 27).

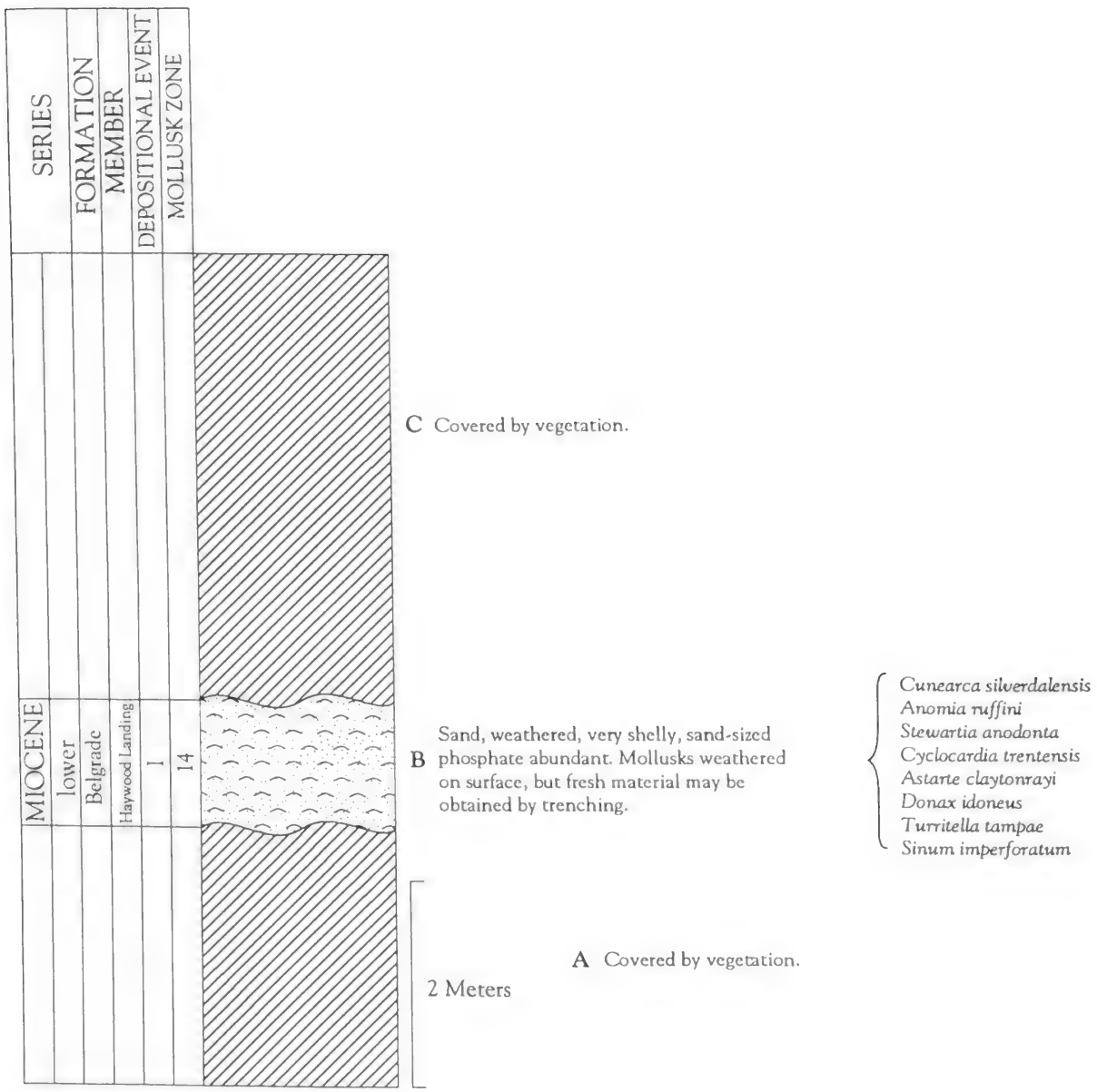


Figure 32.—Haywood Landing, left bank of the White Oak River, 1.2 km below the mouth of Holston Creek, Jones County, N.C. (Locality 28).

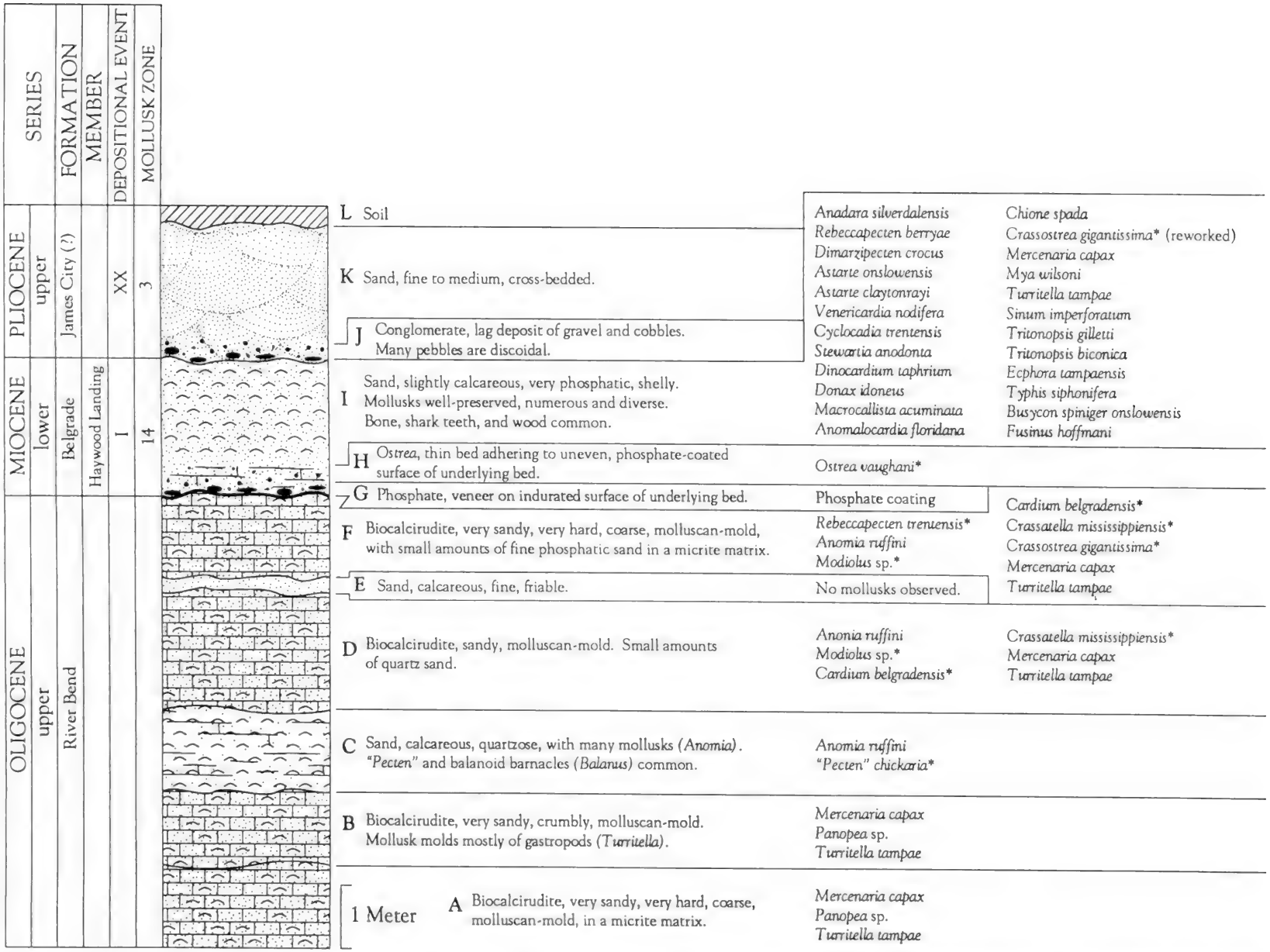


Figure 33.—Martin Marietta Co. Belgrade Quarry, just east of the intersection of Rte. 17 and Rte. 1434, Onslow County, N.C. (Locality 29). Asterisk (*) indicates mollusks not found in the Miocene and not figured or treated in the systematics.

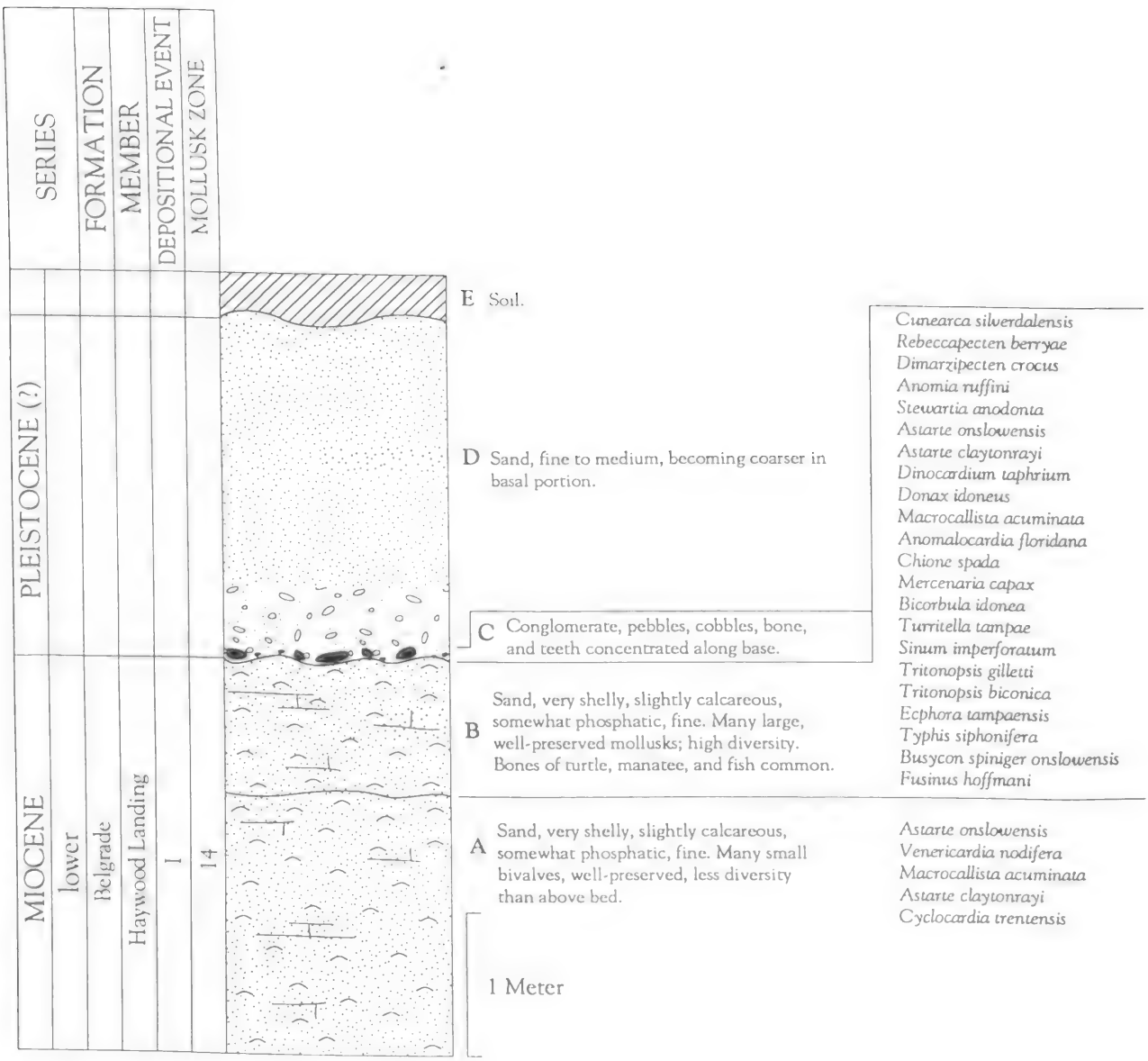


Figure 34.—Silverdale Marl Quarry at Silverdale, 0.4 km southeast of the intersection of Rte. 1434 and Rte. 1443, Onslow County, N.C. (Locality 30).

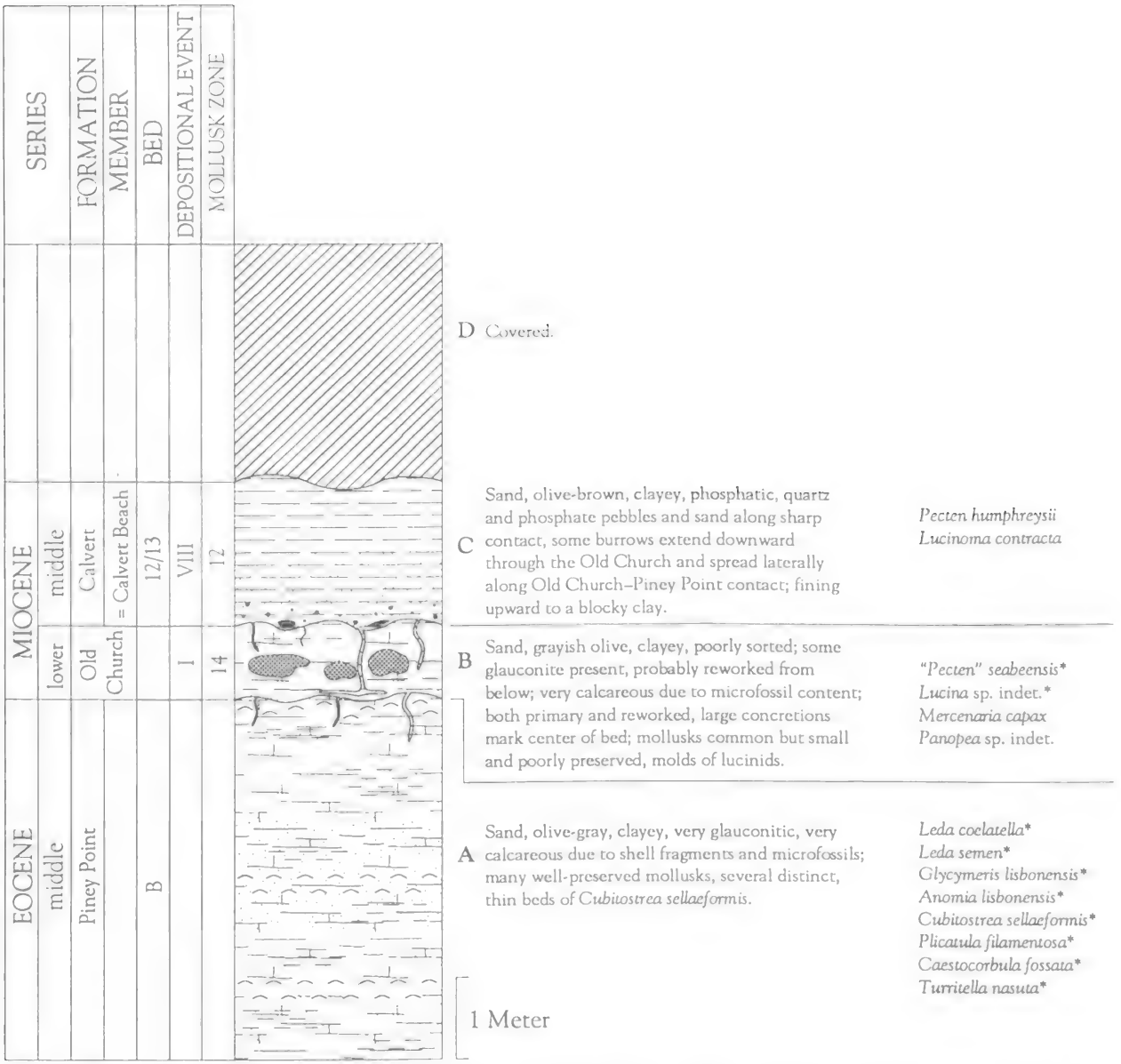


Figure 35.—Right bank of the Pamunkey River at Horseshoe, Hanover County, Va., Manquin 7.5 minute quadrangle (Locality 31). Asterisk (*)indicates mollusks not found inthe Miocene and not figured or treated in the systematics.

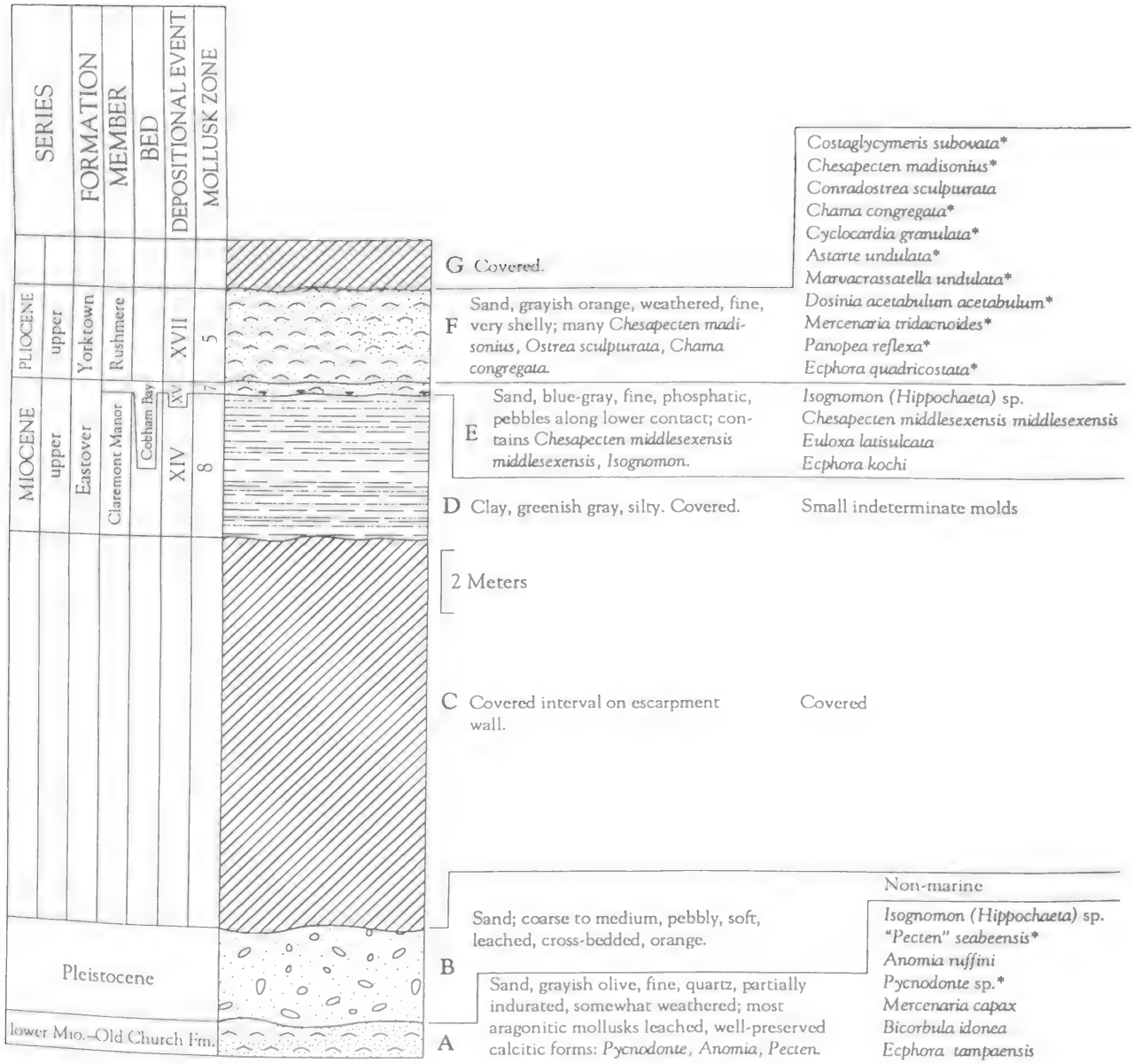


Figure 36.—Warren Brothers sand pits, 2.3 km southeast of Bottoms Bridge, 3.2 km northeast of Elko, Henrico County, Va. (Locality 32). The Yorktown and Eastover Formations are exposed in a gully on the adjacent river escarpment. The Old Church Formation was exposed in the bottom of the pit below the terrace gravels; the pits are now flooded. Asterisk (*) indicates mollusks not found in the Miocene and not figured or treated in the systematics.

SYSTEMATICS

The synonomies in the systematics section are not necessarily complete but do reflect significant changes in nomenclature and consist of publications in which the various taxa were best described or figured. Institutional names are abbreviated and include the following:

ANSP—The Academy of Natural Sciences of Philadelphia
BM(NH)—British Museum (Natural History)
USGS—U.S. Geological Survey
USNM—National Museum of Natural History
PRI—Paleontological Research Institution

All measurements are given in millimeters (mm).

Class BIVALVIA Linné, 1758
Subclass PTERIOMORPHIA Beurlen, 1944
Order ARCOIDA Stoliczka, 1871
Superfamily ARCOIDEA Lamarck, 1809
Family ARCIDAE Lamarck, 1809
Subfamily ANADARINAE Reinhart, 1935

Genus *Cunearca* Dall, 1898

Discussion.—The genus *Cunearca* is best recognized by its distinct beaded or noded ribbing. This effect is the result of relatively wide ribbing which is intersected by concentric growth lines. Where the two intersect, a wide node is developed. Members of the genus include *C. silverdalensis* (Kellum) from the Belgrade Formation (lower Miocene); *C. scalaris* (Conrad) from the Yorktown Formation, Rushmere Member (upper Pliocene); *C. scalarina* (Heilprin) from the Caloosahatchie Formation (upper Pliocene and lower Pleistocene); and *C. brasiliana* (Lamarck) (genotype of *Cunearca*), which is living today from North Carolina to Brazil. Members of the genus *Cunearca* appear to prefer subtropical to tropical conditions. This may explain their spotty record on the middle Atlantic slope during the Miocene and Pliocene.

Cunearca silverdalensis (Kellum, 1926)
Plate 24, figure 11

Arca (*Scapharca*) *silverdalensis* Kellum, 1926, p. 34, Pl. 8, figs. 1–3.
Anadara (*Anadara*) *silverdalensis* (Kellum). Bird, 1965, p. 27, Pl. 2, figs. 1–3.

Discussion.—*Cunearca silverdalensis* is the oldest known member of the *Cunearca* lineage. The species has the distinct beaded or noded ribbing characteristic of the genus. The specimen figured herein is Kellum's (1926) type (USNM 353302). *Cunearca silverdalensis* is certainly related to *Anadara mummi* Mansfield and *Arca lesueuri* Dall from the Oligocene of the Gulf Coastal Plain. Those taxa differ in having ribs which tend to bifurcate. *Cunearca scalaris* (Conrad) and *C. scalarina* (Heilprin) are much larger forms than *C. silverdalensis* and are proportionately higher and deeper-valved.

Type information.—Holotype: USNM 353302. Type locality: Silverdale, Onslow County, N.C.

Figured specimen.—Holotype, USNM 353302.

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene–lower Miocene), North Carolina.

Genus *Rasia* Gray, 1857
Rasia arata (Say, 1824)
Plate 1, figure 5

Arca arata Say, 1824, p. 137, Pl. X, fig. 1.
Arca arata Say. Conrad, 1845, p. 58, Pl. XXX, fig. 6.
Scapharca (*Arca*) *arata* Say. Conrad, 1863*b*, p. 579.
Scapharca (*Scapharca*) *arata* Say. Dall, 1898*b*, p. 643.

Discussion.—*Rasia arata* was collected by John Finch from Miocene beds exposed on the York River above Yorktown, Va., and not from Maryland as Say's title would suggest. An examination of the type of this taxon, BM(NH) L13207, and the other fossil forms described by Say (1824) has convinced me that they were all collected by Finch from the bluffs in the vicinity of Yorktown. A few specimens in Finch's collection, such as *Rasia arata*, came from beds now known as the Eastover Formation, but most came from the Yorktown Formation. Finch (1833) described his travels in Virginia, and his section on Yorktown (pages 273–274) makes it clear that he collected specimens there that were given to Say for description. Specifically mentioned was "*Venus deformis* Say" [=*Mercenaria tridacnoides* (Lamarck)].

The bluffs along the York River above Yorktown are now riprapped to protect the Yorktown Battlefield Park. As a result, the natural exposures are now mostly covered. The Cobham Bay Member of the Eastover Formation is exposed along the James River in Surry County from Lower Chippokes Creek to near Sunken Meadow Creek. *Rasia arata* is present in that

section, but never abundant. Valves of the taxon are relatively common just below Sunken Meadow Creek (locality 7 of this report, USGS locality 26066).

Type information.—Type: BM(NH) L13207. Type locality: Said to be "Maryland" but is probably the bluffs along the York River near Yorktown, Va.

Figured specimen.—Right valve (USNM 405183) from below Sunken Meadow Creek, Surry County, Va. (locality 7).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Rasia andrewsi new species
Plate 8, figure 3

Arca (*Scapharca*) *arata* (Say). Glenn, 1904, p. 388–389, Pl. CV, figs. 7a, 7b. [Not *Arca arata* of Say, 1824].

Anadara arata (Say). Vokes, 1957, p. 9, Pl. 5, figs. 6, 7. [Not *Arca arata* of Say, 1824].

Rasia sp. Ward and Powars, 1989, p. 36, Pl. 10, fig. 3.

Diagnosis.—Elongate and rectangular in outline; ribs number about 28, only slightly elevated, narrow, square in section; shell slightly produced posteroventrally; beak located anteriorly of hinge midpoint.

Description.—Valve elongate, somewhat rectangular in outline and moderately deep. Exterior characterized by about 28 slightly elevated, narrow, squarish ribs. Concentric growth rings conspicuous but not prominent. At least five growth pauses give appearance of shell undulations. Obvious medial sulcus across umbo, directed ventrally, becoming obsolete in later growth stages. Hinge plate wide with long, thin line of small teeth, vertical medially, becoming slanted anteriorly and posteriorly. Hinge plate with several, somewhat interrupted, chevron-shaped, incised lines radiating from the beak. Interior shell margin fluted to correspond with exterior ribs. Pallial line entire and close to exterior margin. Interior of shell relatively deep, especially under the hinge plate, and exhibiting feebly impressed lines radiating from the beak to the pallial line. Anterior muscle scar somewhat triangular, posterior muscle scar rectangular. The holotype (USNM 405184), a left valve, is 30.6 mm in height and 46.2 mm in length. The three paratypes (USNM 405185) are from the same locality (locality 13, USGS locality 26555).

Discussion.—*Rasia andrewsi* is known only from the St. Marys Formation at Chancellor Point on the St. Marys River, St. Marys County, Md. (locality 13, USGS locality 26555). Most of the specimens found there are worn. The holotype is slightly worn and the paratypes even more so. Glenn (1904) and Vokes (1957) identified the taxon as *Arca arata* and *Anadara arata* respectively, but *Rasia arata* and *Rasia andrewsi* differ in several ways. *Rasia arata* is a larger, deeper-valved form, lacking the exterior medial sulcus. In addition, *R. arata* has fewer but heavier ribs than *R. andrewsi*, and its posteroventral margin is more rounded. The two forms are certainly related and both may represent a natural lineage. Forms of the lineage earlier than *R. andrewsi* are unknown and those later than *R. arata* are uncertain. *Sectiarca lienosa* (Say), found in the upper Yorktown Formation (upper Pliocene) is probably related to this lineage, but its ribs are longitudinally striated, making its affinities unclear.

Etymology.—*Rasia andrewsi* is named in honor of Dr. George W. Andrews, recently retired from the U.S. Geological Survey.

Type information.—Holotype: USNM 405184. Type locality: 0.4 km below Chancellor Point, left bank of the St. Marys River, St. Marys County, Md.; St. Marys Formation, Windmill Point Member (locality 13).

Figured specimen.—Holotype USNM 405184.

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland and Virginia.

Genus *Dallarca*, new genus

Diagnosis.—Shell of moderate size, usually short, thick, and deep-valved. Exterior ornamentation consists of numerous thin, strong ribs radiating from a slightly prosocline beak. Ribs average around 25 for the genus. Ribs slightly noded where growth lines intersect ribs. Prominent umbo with distant beaks. Hinge plate strong, wide, with chevron-shaped, incised ligamental grooves radiating from the beak. Teeth numerous, fine. Large, prominent muscle scars. Pallial line sharply defined.

Description.—Shell of moderate size, only slightly longer than high in some species. Valves thick and deep. Unbones high. Beaks usually slightly prosocline. Exterior with numerous, fine, strong ribs radiating from the beak. These average 25 in the genus but number 28 on the type species. Ribs set closely together medially but are farther apart anteriorly and

posteriorly. Some ribs show fine, longitudinal grooving when well-preserved or in young specimens. Ribs are crossed by finely incised growth lines. These are inconspicuous in early shell development but become more obvious in the adult stages. Several growth interruptions give a somewhat undulant appearance to the exterior. On well-preserved valves, the ribs exhibit small nodes. Shell is rounded anteriorly but is produced sharply posteriorly with a sharp shoulder arching to the beak. Exterior margin fluted to match the ribbing. Hinge plate wide, strong, and marked by very fine, horizontal, impressed lines. These lines are crossed by a series (five in the type species) of somewhat sinuous, chevron-shaped, strongly impressed lines. Teeth are numerous, thin, small and vertical medially, larger and somewhat inclined anteriorly and posteriorly. Interior margin strongly fluted in harmony with external ribbing. Pallial line prominent and demarking a small shelf between it and the shell margin. Fine impressed lines radiating from the beak, becoming very strong near pallial line. Anterior muscle scar strong, subrounded, somewhat raised; posterior muscle scar strong, sub-rectangular, also raised. Pedal retractor muscle scars small but well-defined under the hinge plate.

Discussion.—It is incredible that this taxon, so well represented and so often mentioned and illustrated, has not been named. This has mainly been due to the use of inapplicable names of European and Asian forms. Among these are *Scapharca*, *Diluvarca*, and *Anadara*. *Dallarca* lacks the elongate outline, noded and bifurcating ribs, and reduced ligamental area of *Scapharca*. *Diluvarca* has a more elongate, prosocline outline than *Dallarca* and has been placed in synonomy with *Anadara*. *Diluvarca* and *Anadara* are noticeably produced posteriorly and are longer than high. *Dallarca* ranges through the Miocene and into the late Pliocene. It seems to represent a temperate equivalent of its sub-tropical/tropical near-relative *Cunearca* Dall but lacks the conspicuously noded ribs of that taxon. Species assigned to this genus include the following: *D.*(?) *subrostrata* (Conrad, 1841)–Calvert Formation, Plum Point Marl Member (middle Miocene); *D. elnia* (Glenn, 1904)–Choptank Formation, Drumcliff Member (middle Miocene); *D. elevata* Conrad, 1840–Choptank Formation, Boston Cliffs Member (middle Miocene); *D. idonea* ssp.–St. Marys Formation, Little Cove Point Member (upper Miocene); *D. idonea* (Conrad, 1832)–St. Marys Formation, Windmill Point Member (upper Miocene); *D. carolinensis* (Dall, 1898)–Eastover Formation (upper Miocene); *D. carolinensis rotunda* new subspecies–Eastover Formation, Claremont Manor Member (upper Miocene); *D. carolinensis clisea* (Dall, 1898)–Eastover Formation, Claremont Manor Member (upper Miocene); *D. virginiae* (Dall, 1898)–Eastover Formation, Claremont Manor Member (upper Miocene); *D. staminea* (Say)–Yorktown Formation and Raysor Formation (upper Pliocene).

Etymology.—The genus is named in honor of William Healey Dall, one the greats in Tertiary molluscan paleontology.

Type information.—Type species: *Arca idonea* Conrad, 1832. Conrad's type material is in the Academy of Natural Science of Philadelphia but is unnumbered. The specimen selected as lectotype of *Dallarca idonea* is one in which "idonea Conrad" is inscribed, probably by Conrad himself. A number of other specimens of *D. idonea* were in the same tray. One of the specimens appears to agree with Conrad's (1832, Table 1, fig. 2) figure and another seems to agree with Conrad's (1840, Pl. XXIX, fig. 3). Neither of these forms bear any inscription, however. Type locality: Given by Conrad as "St. Mary's River, Md." Probably the same as the author's locality 12 (USGS locality 26554), which is 0.5 km above Windmill Point, right bank of the St. Marys River, St. Marys County, Md.

Stratigraphic and geographic range.—*Dallarca* ranges through most of the Chesapeake Group (lower Miocene to upper Pliocene). It is not known stratigraphically higher than the Yorktown Formation or its equivalents, the Raysor, the Duplin, or the Jackson Bluff Formations.

Dallarca carolinensis carolinensis (Dall, 1898)
Plate 1, figures 6, 8

Arca carolinensis. Name associated with figure on privately circulated plates by Wagner in the middle 1800s. The figured species were never described and were never formally published.

Arca carolinensis Wagner. Bronn, 1850, p. 93. [Name in list].

Arca carolinensis Dall, 1898*a*, p. 9, Pl. 1, fig 4.

Scapharca (*Scapharca*) *carolinensis* Dall. Dall, 1898*b*, p. 639, Pl. 33, fig. 11.

Arca carolinensis Wagner. Sheldon, 1916, p. 42, Pl. X, figs. 1, 2.

Anadara carolinensis (Wagner). Gardner, 1943, p. 25, Pl. 2, fig. 6.

Anadara (*Anadara*) *carolinensis* (Dall). Bird, 1965, p. 28, Pl. 1, fig. 9.
Scapharca carolinensis (Dall). Ward and Blackwelder, 1980, Pl. 2, figs. 2, 3.
"*Arca*" *carolinensis* Dall. Ward, 1984, p. 63, Pl. 10, figs. 2, 3.
"*Arca*" *carolinensis* Dall. Ward, 1985*b*, p. 53, Pl. 10, figs. 2, 3.
"*Arca*" *carolinensis* Dall. Ward, 1985*c*, Pl. 10, figs. 2, 3.
"*Arca*" *carolinensis* Dall. Ward, 1987, p. 137, Pl. 10, figs. 2, 3.
"*Arca*" *carolinensis* Dall. Ward, 1989, p. 87, Pl. 10, figs. 2, 3.
"*Arca*" *carolinensis* Dall. Ward and Powars, 1989, p. 40, Pl. 14, figs. 2, 3.
"*Arca*" *carolinensis* Dall. Ward, *in* Johnson et al., 1990, Pl. 10, figs. 2, 3.

Discussion.—Since Wagner never published his plates, the names assigned to the various taxa by him never were formalized. When Dall finally published Wagner's plates in 1898, he added short descriptions of the figured species. This publication would seem to make Dall the author. When Dall treated the Arcidae later that year in the same series, he again described the taxon and stated (Dall, 1898*b*, p. 639) that his description was based on the type specimen. A check by the author at the Wagner Free Institute of Science of Philadelphia proved unsuccessful and, as yet, the whereabouts of the Wagner collection is unknown. A specimen of *D. carolinensis carolinensis* (Dall) in the National Museum of Natural History (USNM 149020) is labeled as being from Wagner's type lot. As the type appears to be lost, this specimen is herein considered the neotype. It is clearly a form typical of those found in the Cobham Bay Member of the Eastover Formation. The squarish form of the taxon is somewhat irregular, and in some specimens it is somewhat produced posteriorly. The species may merge with *D. carolinensis clisea* (Dall). The elongate shape may be due to the clayey substrates encountered in the Claremont Manor sea, while the squarish shapes found in the Cobham Bay may be due to the cleaner, sandier sediments.

Type information.—Neotype: USNM 149020. Type locality: York River at Bellefield above Yorktown, York County, Va. This is Harris's collection station 2250. Harris (1890) mentioned the occurrence of *Perna maxillata* (=*Isognomon* (*Hippochaeta*) sp.) in that area, which is a reliable indicator of the presence of the Eastover Formation. It is this author's opinion that Harris's, and therefore Dall's, specimen came from the Cobham Bay Member of the Eastover Formation at Bellefield.

Figured specimens.—Right and left valves USNM 258360. Specimen from 2.7 km below Bowlers Wharf on the Rappahannock River, Essex County, Va. (locality 2).

Stratigraphic and geographic range.—Eastover Formation (upper Miocene) in Virginia and North Carolina.

Dallarca carolinensis clisea (Dall, 1898)
Plate 5, figure 3

Scapharca (*Anadara*) *clisea*. Dall, 1898*b*, p. 657, Pl. 33, fig. 25.
Arca (*Scapharca*) *clisea* Dall. Glenn, 1904, p. 386, Pl. CV, fig. 1.
Arca clisea Dall. Sheldon, 1916, p. 52, Pl. XII, figs. 7, 8.
Scapharca clisea (Dall). Ward and Backwelder, 1980, Pl. 1, fig. 7.
"*Arca*" *carolinensis clisea* (Dall). Ward, 1984, p. 63, Pl. 9, fig. 7.
"*Arca*" *carolinensis clisea* (Dall). Ward, 1985*b*, Pl. 9, fig. 7.
"*Arca*" *carolinensis clisea* (Dall). Ward, 1985*c*, Pl. 9, fig. 7.
"*Arca*" *carolinensis clisea* (Dall). Ward, 1987, p. 136, Pl. 9, fig. 7.
"*Arca*" *carolinensis clisea* (Dall). Ward, 1989, p. 86, Pl. 9, fig. 7.
"*Arca*" *carolinensis clisea* (Dall). Ward and Powars, 1989, p. 39, Pl. 13, fig. 7.
"*Arca*" *carolinensis clisea* (Dall). Ward, *in* Johnson et al., 1990, Pl. 9, fig. 7.

Discussion.—*Dallarca carolinensis clisea* (Dall) is considered by this author to be a subspecies of *D. carolinensis carolinensis* (Dall) since end members of their populations seem to merge in form. The majority of specimens found in the Claremont Manor Member of the Eastover Formation are extremely produced posteriorly like the figured specimen, but a few specimens approach the squarish form of typical *D. carolinensis carolinensis* Dall. *Dallarca c. clisea* Dall occurs over the entire extent of the Claremont Manor Member, but the best preserved specimens come from the section of cliffs just upriver and just downriver from Claremont, Surry County, Va.

Type information.—Holotype: USNM 107721. Type locality: Dall (1898*b*, p. 657) mentions the taxon as occurring in Maryland, Virginia, and Florida, but his figured and described specimen came from the Nomini Cliffs, Westmoreland County, Va. and was collected by Harris (USGS locality 2344).

Figured specimen.—Left valve (USNM 258353) from just downriver of the mouth of Upper Chippokes Creek on the James River, Surry County, Va. (USGS locality 26042).

Stratigraphic and geographic range.—Eastover For-

mation, Claremont Manor Member (upper Miocene) in Virginia.

Dallarca carolinensis rotunda, new subspecies
Plate 5, figures 6, 7

"*Arca*" *carolinensis* ssp. Ward, 1984, p. 63, Pl. 8, figs. 1, 2.
"*Arca*" *carolinensis* ssp. Ward, 1985*b*, Pl. 8, figs. 1, 2.
"*Arca*" *carolinensis* ssp. Ward, 1985*c*, Pl. 8, figs. 1, 2.
"*Arca*" *carolinensis* ssp. Ward, 1987, p. 135, Pl. 8, figs. 1, 2.
"*Arca*" *carolinensis* ssp. Ward, 1989, p. 85, Pl. 8, figs. 1, 2.
"*Arca*" *carolinensis* ssp. Ward and Powars, 1989, p. 38, Pl. 12, figs. 1, 2.
"*Arca*" *carolinensis* ssp. Ward, *in* Johnson et al., 1990, Pl. 8, figs. 1, 2.

Diagnosis.—Shell average size for genus and species but much less inflated; less produced posteriorly, almost round in outline.

Description.—Shell medium size, moderately inflated, circular in outline with a wide cardinal area impressed with three chevron-shaped ligamental grooves. Hinge line almost straight with about 50 small teeth, upright in the middle half of the hinge plate, inclined outward distally. Exterior covered with 30 strong, closely spaced ribs. Ribs noded from intersection of growth lines. Eight anterior ribs with a longitudinally impressed line. Interspaces one-third the size of the exterior ribs. Interior margin of the valve fluted to reflect the exterior ribs, which may be faintly seen about one-half of the distance to the beak. Muscle scars of average size; ovate anteriorly and slightly larger and elongate posteriorly. This species is inequivalved with one valve slightly overlapping the other in paired specimens. The figured specimen measures 54.5 mm in height and 55.6 mm in length.

Discussion.—This is a common taxon in the Claremont Manor Member of the Eastover Formation and is notable for its low unbones and circular outline. The shell is relatively thin in comparison with other species of *Dallarca* of comparable size. Best specimens may be obtained in the Claremont Manor Member of the Eastover Formation from Claremont Wharf to Cobham Wharf, Surry County, Va., where it co-occurs with *D. c. clisea* and *D. virginiae*.

Type information.—Holotype: USNM 380702. Type locality: Just above the mouth of Sunden Meadow Creek on the right bank of the James River, Surry County, Va. (USGS locality 26041).

Figured specimen.—Holotype (USNM 380702).

Stratigraphic and geographic range.—Eastover Formation, Claremont Manor Member (upper Miocene) in Virginia.

Dallarca virginiae (Dall, 1898)
Plate 5, figure 1

Arca virginiae Name given to figure on privately circulated plates by Wagner in the mid-1800s.
Arca virginiae Wagner. Bronn, 1850, p. 99. [Name in list].
Arca virginiae Wagner. Dall, 1898*a*, p. 9, Pl. 1, fig. 3.
Barbatia (*Granoarca*) *virginiae* Wagner. Dall, 1898*b*, p. 627–628, Pl. 32, fig. 23.
Arca (*Barbatia*) *virginiae* Wagner. Glenn, 1904, p. 392–393, Pl. CVI, fig. 8.
Arca virginiae Wagner. Sheldon, 1916, p. 19, pl IV, figs. 2, 3, 4.
Scapharca virginiae (Dall). Ward and Blackwelder, 1980, Pl. 1, fig. 5.
"*Arca*" *virginiae* (Dall). Ward, 1984, Pl. 9, fig. 5.
"*Arca*" *virginiae* (Dall). Ward, 1985*b*, Pl. 9, fig. 5.
"*Arca*" *virginiae* (Dall). Ward, 1985*c*, Pl. 9, fig. 5.
"*Arca*" *virginiae* (Dall). Ward, 1987, p. 136, Pl. 9, fig. 5.
"*Arca*" *virginiae* (Dall). Ward, 1989, p. 86, Pl. 9, fig. 5.
"*Arca*" *virginiae* (Dall). Ward and Powars, 1989, p. 39, Pl. 13, fig. 5.
"*Arca*" *virginiae* (Dall). Ward, *in* Johnson et al., 1990, Pl. 9, fig. 5.

Discussion.—Dall (1898*a*) first published Wagner's plates that figured this taxon but listed no locality. Later in that same year (1898*b*) Dall revised its generic assignment and gave a complete description of Wagner's type, which Dall said was still in the Wagner Free Institute of Philadelphia. I have been unable to find the type.

Type information.—Type: Not found; said by Dall to be in the Wagner Free Institute. I designate herein the figured specimen (USNM 258351) as neotype. Type locality: Dall (1898*a*) did not comment on the locality, but later (1898*b*) he mentioned, questionably, the Nansemond River. No deposits of Claremont Manor Member are known to occur on the Nansemond River; only the Yorktown Formation is exposed there. *Dallarca virginiae* (Dall) is common in the bluffs along the James River from Claremont to Cobham Wharf in Surry County but does not occur in the Yorktown Formation.

Figured specimen.—Neotype (USNM 258351), from just above Sunken Meadow Creek, Surry County, Va. (USGS locality 26041).

Stratigraphic and geographic range.—Eastover Formation, Claremont Manor Member (upper Miocene) in Virginia.

Dallarca idonea (Conrad, 1832)
Plate 8, figures 1, 2

Arca idonea Conrad, 1832, p. 16, tab. 1, fig. 5.
Arca stillicidium Conrad, 1832, p. 15, tab. 1, fig. 3.
Arca idonea Conrad. Conrad, 1840, p. 55, Pl. XXIX, fig. 3.
Scapharca (Arca) idonea Conrad. Conrad, 1863*b*, p. 579.
Scapharca (Scapharca) idonea Conrad. Dall, 1898*b*, p. 639.
Arca (Scapharca) idonea Conrad. Glenn, 1904, p. 387, 389, Pl. CVI, figs. 1, 2.
Arca idonea Conrad. Sheldon, 1916, p. 41, Pl. IX, figs. 14–17.
Arca (Anadara) idonea Conrad. Mongin, 1959, p. 287–290, Pl. 24, fig. 1 a–d.
Dallarca idonea (Conrad). Ward and Powars, 1989, p. 36, Pl. 10, figs. 1, 2.

Discussion.—Since the description of *Dallarca idonea* is preceded by that of *D. stillicidium* in the same journal, that name would have priority. However, Conrad (1840) considered *D. stillicidium* to be the young of *D. idonea* and placed the former in synonomy with the latter. The type of *D. stillicidium* (ANSP 18844) is somewhat smaller than that of *D. idonea*, but is not a juvenile. Since *D. idonea* is the generally accepted name and *D. stillicidium* has not been used for over 50 years, it is preferable to use the former for the taxon. I have chosen (this volume) *D. idonea* (Conrad) as the type species for the genus *Dallarca*, an important and widespread Miocene and Pliocene lineage. The species is abundant in the type area along the St. Marys River, St. Marys County, Md. (Localities 12, 13, USGS Localities 26554, 26555) and in Virginia at Essex Mill (locality 14, USGS locality 26091) and White Oak Landing (locality 8, USGS locality 26046).

Type information.—Lectotype: ANSP, not numbered. Conrad (1832, 1840) figured two different specimens, both of which are still retained in Conrad's type material. Another specimen contains the inscription "idonea Conrad" written inside the right valve, apparently by Conrad himself. It is this specimen that I have chosen as lectotype of *D. idonea* and to base the genus *Dallarca*. Measurements of the type species: Left valve, length 61.2 mm, height 55.0 mm, convexity 25.7 mm; right valve, length 61.3, height 55.1 mm, convexity 24.8 mm. Type locality: The "St. Mary's River, St. Marys County, Md." (Conrad, 1832, p. 16).

Figured specimen.—Left valve (USNM 405186), from 0.5 km upriver of Windmill Point, right bank of the St. Marys River, St. Marys County, Md. (locality 12, USGS locality 26554).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds in Maryland and Virginia (upper middle Miocene).

Dallarca idonea, subspecies?
Plate 11, figures 1, 5

Discussion.—The specimens of *Dallarca* so abundant in the Little Cove Point beds of the St. Marys may only be the young of *D. idonea* or may be a subspecies of that taxon. The Little Cove Point form is notably smaller in size, but this may be merely a function of environment. In its early growth stages, the Little Cove Point forms are very similar to the young of *D. idonea*. The stratigraphically earliest forms of *D. idonea*, ssp? in the Little Cove Point are very different from *D. elevata* Conrad, 1840, which is found in the Boston Cliffs Member of the Choptank Formation. It is believed, therefore, that an appreciable amount of time separates the occurrence of the two taxa.

Figured specimens.—Plate 11, fig. 1: Left valve (USNM 405187) from 1.0 km below Little Cove Point, western shore of the Chesapeake Bay, Calvert County, Md. (locality 15). Plate 11, fig. 5: Left valve (USNM 405188) from the same locality.

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point Member (lower upper Miocene) in Maryland.

Dallarca elevata (Conrad, 1840)
Plate 14, figures 9, 10

Arca elevata Conrad, 1840, second page of front cover.
Arca callipleura Conrad, 1840, p. 54, Pl. XXIX, fig. 2.
Arca triquetra Conrad, 1843*a*, p. 305.
Arca triquetra Conrad. Conrad, 1845, p. 59, Pl. XXXI, fig. 2.
Scapharca callipleura Conrad. Conrad, 1863*b*, p. 579.
Scapharca triquetra Conrad. Conrad, 1863*b*, p. 580.
Arca (Scapharca) callipleura Conrad. Whitfield, 1894, p. 43, Pl. VI, figs. 8, 9.
Scapharca (Scapharca) staminea Say. Dall, 1898*b*, p. 642 [In part]. [Not *Arca staminea* of Say, 1832].
Arca (Scapharca) staminea Say. Glenn, 1904, p. 387–388, Pl. CV, figs. 2–6. [Not *Arca staminea* of Say, 1832].
Arca staminea Say. Sheldon, 1916, p. 39–40, Pl. IX, figs. 7–13. [Not *Arca staminea* of Say, 1832].
Anadara staminea (Say). Schoonover, 1941, p. 21–23, Pl. 1, figs. 6, 7. [In part]. [Not *Arca staminea* of Say, 1832].
Anadara staminea (Say). Vokes, 1957, p. 9, Pl. 5, figs. 3, 4. [Not *Arca staminea* of Say, 1832].
Arca (Anadara) staminea Say. Mongin, 1959, p. 290–291, fig. 2a,b. [Not *Arca staminea* of Say, 71832].

Discussion.—It can be seen by the long synonomy that this form from the upper Choptank Formation has been treated extensively in the literature. Because it is somewhat variable in form, *D. elevata* was given three different names by Conrad. Later workers applied the name *D. staminea* (Say, 1832, Pl. XXXVI, fig. 2) to the same taxon that Conrad referred to *D. elevata*. *Dallarca staminea*, however, came from the upper Pliocene beds of South Carolina and is not closely related to *D. elevata*. *Dallarca elevata* has a very characteristic, rectangular shell margin. Its predecessor *D. elnia*, from the lower part of the Choptank Formation, has a much more rounded ventral margin. The species is concentrated in thin beds and occurs most commonly as paired valves in the Boston Cliffs Member ("zone" 19 of Shattuck, 1904) of the Choptank Formation.

Type information.—Lectotype: Two specimens in Conrad's lot of *Dallarca idonea* at the Academy of Natural Sciences of Philadelphia are referable to *D. elevata*. These specimens may belong to the missing type lot of that taxon. One of the two, a left valve with a naticid boring anteriorly, is herein selected as the lectotype of the species. The specimens belong to the Academy of Natural Sciences of Philadelphia but have not been assigned numbers. Type locality: "Choptank River, Maryland." The type lot probably came from Boston Cliffs on the Choptank River, near Easton, Md.

Figured specimen.—Left valve (USNM 405189) from below Flag Pond, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 17).

Stratigraphic and geographic range.—Choptank Formation, Boston Cliffs Member (Zone 19 of Shattuck, 1904) (upper middle Miocene) in Maryland and Virginia.

Dallarca elnia (Glenn, 1904)
Plate 16, figure 6

Arca (*Scapharca*) *elnia* Glenn, 1904, p. 386, Pl. CIV, figs. 4a, 4b.
Arca elnia Glenn. Sheldon, 1916, p. 51–52, Pl. XII, figs. 5, 6.
Anadara staminea (Say). Schoonover, 1941, p. 21–23, Pl. 1, fig. 5 [In part]. [Not *Arca staminea* of Say, 1832].
Dallarca elnia (Glenn). Ward and Powars, 1989, p. 34, Pl. 8, fig. 6.

Discussion.—The relative absence of records for this species is due principally to its confusion with *Dallarca elevata* (Conrad, 1840) (=*D. staminea* of several authors, not Say). The species is very common in the Drumcliff Member of the Choptank Formation and can be distinguished from *D. elevata* by its much more rounded ventral margin, smaller ligamental area, and more medially placed beaks.

Type information.—Type: USNM 360930. Type locality: Jones Wharf, on the Patuxent River, St. Marys County, Md.

Figured specimen.—Left valve (USNM 405190) from Drumcliff (Jones Wharf), on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Choptank Formation, Drumcliff Member (middle middle Miocene) in Maryland.

Dallarca(?) *subrostrata* (Conrad, 1841)
Plate 20, figure 5

Arca subrostrata Conrad, 1841, p. 30.
Arca subrostrata Conrad. Conrad, 1842*a*, p. 185.
Arca subrostrata Conrad. Conrad, 1845, p. 58, Pl. XXX, fig. 7.
Scapharca (*Arca*) *subrostrata* Conrad. Conrad, 1863*b*, p. 580.
Scapharca tenuicardo Conrad, 1869*c*, p. 39.
Scapharca subrostrata Conrad. Whitfield, 1894, p. 45, Pl. VI, figs. 11–13.
Arca (*Scapharca*) *subrostrata* Conrad. Glenn, 1904, p. 385, Pl. CIV, figs. 2, 3.
Arca subrostrata Conrad. Sheldon, 1916, p. 51, Pl. XII, figs. 1, 3, 4.
Anadara subrostrata (Conrad). Schoonover, 1941, p. 21, Pl. 1, figs. 2–4.
Anadara subrostrata (Conrad). Vokes, 1957, p. 9, Pl. 5, figs. 1, 2.
Arca (*Anadara*) *subrostrata* Conrad. Mongin, 1959, p. 291.
Anadara subrostrata (Conrad). Blackwelder and Ward, 1976, p. 42, Pl. 1, fig. 2.

Discussion.—This species differs somewhat from the others assigned to the genus *Dallarca* but is provisionally placed in that genus. The young of *D. subrostrata* are very similar to the young of the other taxa assigned to that genus but the adults are elongate posteriorly, and their ribs have a thin, longitudinal groove. *Dallarca subrostrata* is common only in Bed 10 of the Plum Point Marl Member of the Calvert Formation and may also occur in Bed 12 but, specimens from that unit are generally poorly preserved.

Type information.—Lectotype: ANSP 14027. No specimen in Conrad's type lot matches his first illustration of the species (Conrad, 1845, Pl. XXX, fig. 7). I have chosen the right valve of an adult specimen from Conrad's material (see Plate 20, figure 5) as lectotype. Type locality: "Calvert Cliffs, Maryland."

Specimens from the type lot probably come from Shattuck's (1904) "Zone" 10 in the Calvert Cliffs, Calvert County, Md.

Figured specimen.—Lectotype (ANSP 14027), from the "Calvert Cliffs, Maryland."

Stratigraphic and geographic range.—Calvert Formation, Fairhavem Member (lower Miocene) and Plum Point Marl Member (lower middle Miocene) in Maryland and Virginia.

Family NOETIIDAE Stewart, 1930
Subfamily STRIARCINAE MacNeil, 1938
Genus *Striarca* Conrad, 1863

Striarca centenaria (Say, 1824)
Plate 1, figure 1

Arca centenaria Say, 1824, p. 138, Pl. X, fig. 2.
Arca centenaria Say. Conrad, 1832, p. 16, Pl. 1, fig. 4.
Arca centenaria Say. Conrad, 1840, p. 55, Pl. XXIX, fig. 4.
Arca centenaria Say. Emmons, 1858, p. 285, fig. 205.
Striarca (Arca) centenaria Say. Conrad, 1863*a*, p. 290.
Arca (Striarca) centenaria Say. Whitfield, 1894, p. 42, Pl. VI, figs. 5-7.
Barbatia (Striarca) centenaria Say. Dall, 1898*b*, p. 628, Pl. IV.
Arca (Barbatia) centenaria (Say). Glenn, 1904, p. 391, Pl. CVI, figs. 5, 6.
Arca centenaria Say. Sheldon, 1916, p. 19, Pl. IV, figs. 5–7.
Striarca centenaria (Say). Bird, 1965, p. 26, Pl. 1, figs. 6a, 6b.

Discussion.—*Striarca centenaria* (Say) is common in the Cobham Bay Member of the Eastover Formation in the James River area. It is present in the Claremont Manor Member of the same formation but not common. It has been reported from the Calvert and Choptank Formations in Maryland but is rare in those units. The species becomes common in the Rushmere and Moore House Members of the Yorktown Formation. The genus is not recorded as living in North American waters by Abbott (1974) but is recorded in the western Pacific.

Type information.—Type: BM(NH) L13206. Type locality: Said to be "Maryland" but is probably the bluffs along the York River near Yorktown, Va.. See the discussion on *Rasia arata* (Say).

Figured specimen.—Right valve (USNM 405191) from the Cobham Bay Member of the Eastover Formation, below the mouth of Sunken Meadow Creek, Surry County, Va. (locality 7).

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, bed 10 (lower middle Miocene), Choptank Formation, Drumcliff Member (middle middle Miocene), Eastover and Yorktown Formations (upper Miocene to upper Pliocene) from Maryland, Virginia, and North Carolina.

Superfamily LIMOPSOIDEA Dall, 1895
Family GLYCYMERIDIDAE Newton, 1922
Subfamily GLYCYMERIDINAE Newton, 1922
Genus *Glycymeris* da Costa, 1778

Glycymeris parilis (Conrad, 1843)
Plate 20, figure 2

Pectunculus lentiformis Conrad. Conrad, 1842*b*, p. 181, 183. [name used in list]
Pectunculus parilis Conrad, 1843*a*, p. 306.
Pectunculus parilis Conrad. Conrad, 1845, p. 64, Pl. 36, fig. 2.
Axinaea parilis Conrad. Conrad, 1863*b*, p. 580.
Axinaea lentiformis? Conrad. Whitfield, 1894, p. 49, Pl. VII, figs. 5, 6.
Glycymeris parilis Conrad. Dall, 1898*b*, p. 609.
Glycymeris parilis (Conrad). Glenn, 1904, p. 393–394, Pl. CVII, figs. 1, 2.
Glycymeris parilis (Conrad). Schoonover, 1941, p. 179–182, Pl. 1, figs. 1, 8.
Glycymeris parilis (Conrad). Richards and Harbison, 1942, p. 193, Pl. 7, figs. 16, 17.
Glycymeris parilis (Conrad). Vokes, 1957, p. 8, Pl. 4, figs. 15, 16.
Glycymeris parilis (Conrad). Mongin, 1959, p. 292.
Axinactis (Grandaxinaea) parilis (Conrad). Glibert and van de Poel, 1965, p. 79.
Glycymeris parilis (Conrad). Bird, 1965, p. 39–40, Pl. 4, figs. 2a, 2b, 4a, 4b.

Discussion.—*Glycymeris parilis* Conrad is the only known member of the genus in the Miocene of the Chesapeake Group. The taxon was first referred to as *Pectunculus lentiformis* by Conrad, but that species (=G. *americana* (DeFrance)) is from the upper Pliocene of Virginia and is less rounded, more inflated, and thinner and has finer and more numerous ribs. The genus reappears in the Rushmere Member of the Yorktown Formation (upper Pliocene) with G. *americana* (Defrance). *Glycymeris parilis* is abundant in Bed 10 of the Plum Point Marl Member of the Calvert Formation, where it occurs often as whole individuals. External molds in Bed 2 of the Fairhaven Member of the Calvert Formation are probably G. *parilis*. The genus and the species are characterized by its circular, compressed valves, which are sculptured exteriorly by a large number of narrow, low ribs. The lectotype of G. *parilis* has 39 ribs.

Type information.—Type: Conrad's type material, ANSP 30631, consists of four single-valved specimens and a double-valved specimen that had been broken and repaired. One specimen, ANSP 30631, a left valve with "*parilis*" written inside along with "*A. lentiformis*" (scratched through) and "type," is herein selected as the lectotype. Type locality: "Cliffs of Calvert, Md." (Conrad, 1843*a*, p. 306).

Figured specimen.—Lectotype (ANSP 30631), a left valve.

Stratigraphic and geographic range.—Calvert Formation, Fairhaven and Plum Point Marl Members (lower and lower middle Miocene) in Maryland. Kirkwood Formation (lower Miocene) in New Jersey.

Genus *Costaglycymeris*, new genus

Diagnosis.—Shell of moderate size and thickness, sub-orbicular, low, relatively thick, with 25–35 low, gently rounded or flat ribs separated by deeply impressed linear grooves.

Description.—Shell equivalved with a slightly sub-orbicular outline. Umbones low and gently arched. Posterior margin produced posteriorly and slightly more rounded than the anterior margin. Ribs number 25–35, are low, flat to gently rounded, well-defined and radiate from the moderately prominent beak. Ribs separated by narrow, sharply incised lines or grooves. Ribs broadest near center of valve, becoming narrower anteriorly and posteriorly. Ribs punctuated by inconspicuous, concentric, incremental lines at regular intervals. Stronger concentric lines at irregular intervals mark growth pauses. Interior of the disk is faintly striated radially. Small V-shaped crenulations on the interior, ventral margin mark the exterior rib interspaces. Ligament consists of a series of chevron-shaped striae diverging from the beak. Taxodont dentition strong and partially absorbed by the ligamental area in older specimens. Anterior muscle scar trigonal, the posterior scar subrounded and slightly buttressed.

Discussion.—The ribbed glycymerids that are so abundant in the Miocene and Pliocene beds of eastern North America have been repeatedly lumped in the genus *Glycymeris* da Costa and its many synonyms. *Glycymeris* has fine radial ornamentation and not pronounced ribbing like *Costaglycymeris*. Ribbed forms from Australia such as *Tucetona* Iredale have approximately the same shape as *Costaglycymeris* but differ in having no radial striae. *Tucetona* also has pronounced incremental lines on the ribs.

The first known appearance of *Costaglycymeris* in the Atlantic Coast Tertiary is in the Chipola Formation of west Florida. It was well represented until the late Pliocene, at which time it apparently became extinct. Some of the species that belong in this taxon are *C. drymanos* (Gardner, 1926*a*), *C. waltonensis* (Gardner, 1926*a*), *C. subovata* (Say, 1824), *C. virginiae* (Dall, 1898), and *C. mixoni*, new species.

Say's (1824) *Pectunculus subovata* is herein designated the type species.

Type information.—Type species: based on *Pectunculus subovata* Say, 1824, the type of which is BM (NH) L13209. Type locality: Said to be from Maryland but probably from the Yorktown Formation in the vicinity of Yorktown, York County, Va. (see Ward and Blackwelder, 1975 for a discussion of this confusion). See also the discussion of *Rasia arata* (Say, 1824) in this volume.

Stratigraphic and geographic range.—Chipola Formation (lower Miocene) of Florida; Oak Grove and Shoal River Formations (middle Miocene) of Florida; Eastover Formation (upper Miocene) of Virginia; Yorktown Formation (upper Pliocene) and Chowan River Formation (upper Pliocene) of Virginia and North Carolina.

Costaglycymeris mixoni, new species
Plate 1, figures 2, 3

Glycymeris tumulus (Conrad). Gardner, 1943 [1944], p. 27, Pl. 1, fig. 6, 12–15. (not *G. tumulus* Conrad, 1845).
Glycymeris sp. Ward and Blackwelder, 1980, Pl. 2, fig. 4.
Glycymeris sp. Ward, 1984, p. 63, Pl. 10, figs. 4, 5.
Glycymeris sp. Ward, 1985*b*, p. 63, Pl. 10, figs. 4, 5.
Glycymeris sp. Ward, 1985*c*, Pl. 10, figs. 4, 5.
Glycymeris sp. Ward, 1987, p. 137, Pl. 10, figs. 4, 5.
Glycymeris sp. Ward, 1989, p. 87, Pl. 10, figs. 4, 5.
Glycymeris sp. Ward and Powars, 1989, p. 40, Pl. 14, figs. 4, 5.
Glycymeris sp. Ward, *in* Johnson et al., 1990, Pl. 10, figs. 4, 5.

Diagnosis.—Shell average size for genus, subovate and tumid, with impressed striae which separate very low radial ribs.

Description.—Gardner (1943 [1944], p. 27) described the specimen she called "*Glycymeris tumulus*" as follows:

"Shell evenly rounded ventrally, cuneate dorsally, decidedly tumid in the umbonal region. Radial sculpture absent laterally, obsolete ventrally, consist-

ing of about 21 feebly impressed grooves; faint secondary striae occasionally discernible on the interareas. Growth lines prominent near the ventral margin. Cardinal area high, ornamented with broad, shallow furrows. Hinge line strongly arched. Hinge teeth in two discrete series, 12 or 13 in each; denticles coarse, obliquely set, the dorsal surface finely striated horizontally. Muscle scars conspicuous, semielliptical, united by a simple pallial line. Marginal flutings corresponding in number to the primary lines of the exterior surface."

The holotype, USNM 380782 (Pl. 1, fig. 3), measures 51.9 mm in height and 53.3 mm in length. The paratype, USNM 258361 (Pl. 1, fig. 4), measures 27.9 mm in height and 29.2 mm in length.

Discussion.—Conrad's (1845, p. 72, Pl. 41, fig. 4) figure of *Pectunculus tumulus* resembles this taxon, and Gardner (1943 [1944], p. 27), on the word of Mansfield, concluded that they were the same species. Examination of the type material of *P. tumulus*, however, shows the two species to be very different. The beaks on *P. tumulus* are very produced, the umbones more pronounced than *Costaglycymeris mixoni*, and the "fine decussated striae" described by Conrad are easily seen. Such striae are not present on valves of *C. mixoni*. The syntypes of *P. tumulus* (ANSP 1624) are imbedded in an indurated sandy clay matrix unlike any known lithology in the Cobham Bay Member of the Eastover Formation. Although Conrad (1845) reported the locality as "Petersburg, Va." it is probable that the specimens of *P. tumulus* came from some other locality.

Costaglycymeris mixoni is very common in the Cobham Bay Member along the James River in Surry County, Va. It is also found along the Rappahannock River in Middlesex County, and on the right bank of the Piankatank River in Gloucester County, Va.

Etymology.—The species is named for Dr. Robert B. Mixon of the U.S. Geological Survey.

Type information.—Holotype: USNM 380782. Paratype: USNM 258361. Type locality: Right bank of the James River, 0.8 miles downriver from Cobham Wharf, Surry County, Va. (locality 3).

Figured specimens.—Plate 1, figure 3: Holotype (USNM 380782), from the type locality. Plate 1, figure 2: Paratype (USNM 258361), from the same locality.

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Costaglycymeris virginiae (Dall, 1898)
Plate 5, figure 2

Pectunculus virginiae 18??. [Name given to figure on privately circulated plates by Wagner in the middle 1800s].
Pectunculus virginiae Wagner. Bronn, 1848, p. 940.
Pectunculus virginiae Wagner. Dall, 1898*a*, p. 11, Pl. 3, fig. 5.
Glycymeris virginiae Dall. Blackwelder and Ward, 1976, p. 44, Pl. 2, fig. 3.
Glycymeris virginiae (Dall). Ward and Blackwelder, 1980, Pl. 1, fig. 4.
Glycymeris virginiae (Dall). Ward, 1984, Pl. 9, fig. 4.
Glycymeris virginiae (Dall). Ward, 1985*b*, Pl. 9, fig. 4.
Glycymeris virginiae (Dall). Ward, 1985c, Pl. 9, fig. 4.
Glycymeris virginiae (Dall). Ward, 1987, p. 136, Pl. 9, fig. 4.
Glycymeris virginiae (Dall). Ward, 1989, p. 86, Pl. 9, fig. 4.
Glycymeris virginiae (Dall). Ward and Powars, 1989, p. 39, Pl. 13, fig. 4.
Glycymeris virginiae (Dall). Ward, *in* Johnson et al., 1990, Pl. 9, fig. 4.

Description.—Disk very compressed for its size and subovate. Exterior with about 24 ribs radiating from a prominent, sharp beak area. The ribs have very little relief, being separated by a very shallow, impressed line. The ribs are readily seen in the early growth stages but tend to become obscure or obsolete on adults. Young valves appear almost circular in outline; adults tend to be more teardrop shaped. Interiorly the hinge plate is strongly curved with two widely separated rows of strong teeth at almost right angles to each other. Ventral margin strongly crenulated, corresponding to the interspaces of the exterior ribs. Pallial margin entire and deeply impressed. The two muscle scars are raised, the posterior one ovate, the anterior one elongate.

Discussion.—*Costaglycymeris virginiae* received its specific name based on figures on plates which were privately distributed by Wagner, but were never formally published. The name was later published in a list by Bronn based on those plates, but the species remained undescribed. In January, 1898, Dall (1898*a*) published Wagner's plates with names and short descriptions, in effect making him the author of the taxa though he attributed the names to Wagner. Later, in April, Dall (1898*b*) placed the taxon *Pectunculus virginiae* Wagner in synonomy with *Pectunculus laevis* Tuomey and Holmes, 1856. Gardner (1943 [1944]) also placed *Glycymeris virginiae* in synonomy with *G. laevis* in spite of the fact that the later is a Waccamaw species from South Carolina. In her com-

ments, Gardner noted that G. *laevis* had no radiating sculpture but Dall's (1898*a*) figure of *P. virginiae* clearly exhibits such sculpture. It is my belief that *Costaglycymeris virginiae* is unrelated to *G. laevis*, and it occupies a different stratigraphic horizon. *Costaglycymeris virginiae* (Dall, 1898) possesses clearly defined ribs in the early growth stages, but these become somewhat obscure in the adult. The species is much less tumid than *C. mixoni* Ward, n. sp. and is not as abundant. *Costaglycymeris virginiae* is common in the Claremont Manor Member of the Eastover Formation along the James River in Surry County, Va.

Type information.—Type: The type is said by Dall (1898*a*) to be in the Wagner Free Institute of Science of Philadelphia but has not been located. Accordingly, I herein designate the figured specimen (USNM 258350) as the neotype. Type locality: The type locality was probably in the vicinity of Claremont, Surry County, Va. Four species that Wagner figured are common at that locality. They are *Dallarca virginiae* (Pl. 1, fig. 3), *Dallarca carolinensis carolinensis* (Pl. 1, fig. 4), *Costaglycymeris virginiae* (Pl. 3, fig. 5), and *Discinisca lugubris* Conrad (not Wagner or Dall's name). The neotype comes from downriver of Claremont, 0.8 miles below Cobham Wharf on the right bank of the James River, Surry County, Va., in the Claremont Manor Member.

Figured specimen.—Neotype (USNM 258350).

Stratigraphic and geographic range.—Eastover Formation, Claremont Manor Member (upper Miocene) in Virginia.

Order PTERIOIDA Newell, 1965
Suborder PTERIINA Newell, 1965
Superfamily PTERIOIDEA Gray, 1847
Family ISOGNOMONIDAE Woodring, 1925
Genus *Isognomon* Lightfoot, 1786
Subgenus *Hippochaeta* Philippi, 1844

Isognomon (*Hippochaeta*) sp.
Plate 1, figure 4; Plate 5, figure 4;
Plate 19, figure 5; Plate 21, figure 10

Discussion.—The isognomonids of the Miocene on the Atlantic Coastal Plain are usually broken or worn and therefore difficult to identify. Whole specimens are rare and very difficult to collect. For that reason they are not specifically identified here. However, examination of the specimens illustrated herein suggests that there are probably several species in the Miocene. Large collections will be required to verify this opinion. Any biostratigraphic study of the middle Atlantic Miocene that ignored this taxon, however, would be incomplete, as it sometimes is the dominant species in the assemblage.

The genus *Isognomon* (*Hippochaeta*) is common on the Atlantic Coast of the United States in the Upper Cretaceous (Scotts Hill Member of the Peedee Formation). It disappeared on the Western Atlantic coast of North America but continued in the Gulf of Mexico as evidenced by rare occurences in Midwayan beds (Harris, 1896, p. 162, Pl. 3, figs. 2, 3). It is not known to occur in the Gulf area after the early Paleocene. The genus did not reappear on the Atlantic Coast until the late Oligocene or early Miocene. It is sparingly represented in beds of that age, including the Haywood Landing Member of the Belgrade Formation in North Carolina and the Old Church Formation in Virginia. In both occurences the shell material is fragmentary and scant. The first stratigraphic occurrence in which *Isognomon* appeared in abundance was in the Plum Point Marl Member of the Calvert Formation and specifically "Zone" 10 of Shattuck (1904). Specimens of the genus were also numerous during the middle Miocene in the Drumcliff Member ("Zone" 17 of Shattuck, 1904) of the Choptank Formation. The taxon was present but rare in the St. Marys embayment but again became abundant during the late Miocene in the Eastover embayment. In the Claremont Manor Member of the Eastover, *Isognomon* (*Hippochaeta*) occurs in abundance in thin beds, whereas in the Cobham Bay Member of that formation they make up beds 0.6–1.8 meters thick. In North America, *Isognomon* (*Hippochaeta*) is not known from Pliocene or younger deposits and is presumed to have died out in that area during the interval between the deposition of the Yorktown and the Eastover. This interval probably coincided with a global low stand of the sea and with a cooling event.

Figured specimens.—Plate 1, figure 4: USNM 258364; Plate 5, figure 4: USNM 258347; Plate 19, figure 5: USNM 405192; Plate 21, figure 10: USNM 405193.

Stratigraphic and geographic range.—Belgrade Formation (upper Oligocene and lower Miocene) in North Carolina. Old Church Formation (upper Oli-

gocene and lower Miocene) in Virginia. Calvert and Choptank Formations (lower and middle Miocene) of Maryland and Virginia. St. Marys Formation (upper Miocene) of Maryland and Virginia. Eastover Formation (upper Miocene) of Virginia and North Carolina.

Superfamily PECTINOIDEA Rafinesque, 1815
Family PECTINIDAE Rafinesque, 1815

Genus *Rebeccapecten*, new genus

Diagnosis.—Valves higher than long with a variable number of large, scaly, bifurcating ribs. Shell thick for its size with a deep byssal notch. Right valve deep, left valve nearly flat to slightly concave.

Description.—Disk noticeably higher than long with a variable number (average 10–12) of scaly ribs radiating from a prominent, sharp beak. Ribs variable in size and number. Right valve of young specimens have 10–12 entire ribs with small scales in the very young portion of the shell (up to 7 mm). After that stage the ribs develop a strong medial sulcus as the ribs bifurcate and become more scaly. At an average height of 28 mm the ribs again bifurcate as rib prominence diminishes with each division. Scales become wide, thin plates that stand at nearly right angles to the shell. The right valve is deeply convex with prominent auricles, a deep byssal notch, and a well-defined ctenolium. Left valve moderately convex in the early stages, becoming flat to moderately concave in the adult. Left valve with four or five prominent ribs, the others very small. Bifurcation of the ribs and scaling patterns of the left valve as in the right. Both valves thick for their size. Interiorly the right valve is deep with a rounded ventral margin. Pallial line deep and finely crenulated marking, the distal margin of thick shell material. Muscle scar somewhat posterior, deeply impressed, and nearly circular. Ribbing is reflected only in the distal half of the shelf between the shell margin and the pallial line. Interiorly the left valve is shallow and its ventral margin is angular to match the four or five primary ribs. Left valve in other respects is similar to right valve.

Discussion.—The genus *Rebeccapecten* is founded on the species *Pecten trentensis*, named by G. D. Harris in 1919 in a short paper on Eocene mollusks. Even at that time Harris doubted its Eocene age but provisionally considered it as such. *Rebeccapecten trentensis* is now considered to be Oligocene in age (Ward et al., 1978). *Rebeccapecten trentensis* occurs abundantly in the lower calcareous portion of the River Bend Formation in North Carolina, but also occurs, sparingly, in the upper, arenaceous, mold-and-cast limestone portion of that unit. It is found, but not commonly, high in the upper River Bend in the mold-and-cast limestone, at the Martin Marietta Quarry at Belgrade, Onslow County, N.C. (locality 29, USGS locality 26570). Another species of the genus, *Rebeccapecten berryae*, n. sp. succeeds *R. trentensis* in the Haywood Landing Member of the Belgrade Formation. *Rebeccapecten berryae* is a much larger form. The genus *Nanaochlamys* Hatai and Masuda, 1953 resembles *Rebeccapecten*, but the Japanese taxon is much larger in size and has fewer and larger ribs, which do not bifurcate until a late growth stage.

Etymology.—The genus is named for Rebecca Berry, who worked for the U.S. Geological Survey in 1984–1985.

Type information.—Type species: *Pecten trentensis* Harris is selected as the type species of *Rebeccapecten*. The specimen, PRI 1407, of the Harris collection is designated the lectotype of *P. trentensis*. Paratype, herein designated, PRI 1408. Type locality: "Found in the light, marly bed, right bank of Trent river, near the water's edge, about six miles below Pollocksville, N.C., in the so-called Trent formation" (Harris, 1919, p. 15).

Stratigraphic and geographic range.—River Bend Formation (upper Oligocene) in North Carolina. Haywood Landing Member of the Belgrade Formation (upper Oligocene and lower Miocene) and the basal Pungo River Formation (lower Miocene) in North Carolina.

Rebeccapecten berryae, new species
Plate 24, figure 1

Pecten aff. *P. trentensis* Harris, 1919. Carter et al., 1988, Pl. 7, fig. 50.

Diagnosis.—Disk moderately large, thick, with a variable number of large, very scaly ribs which radiate from a prominent beak.

Description.—Disk somewhat higher than long, moderately large, thick, with a variable number of large, very scaly ribs, which radiate from a sharp, prominent beak. Ribs on the right valve, 10–12 in number, which tend to bifurcate with growth. Five

ribs on the left valve, thin and pronounced with wide interspaces. Scales on the primary ribs wide and thin. Interspaces with numerous thin, scaly, radial striae. Right valve with moderately large byssal notch. Auricles with fine scaly striae radiating from the beak. Umbones low, with the valve slightly arched. Arching interrupted at growth-resting stages to produce a somewhat nodose, undulant exterior. Interior of right valve capacious with a rounded ventral margin. Pallial line noticeable, but not impressed and marking the distal margin of thick shell material. Between the pallial line and shell margin the exterior ribbing is moderately reflected. Muscle scar large, posterior and sub-rounded. Length of holotype: 73.0 mm, height: 75.8 mm, convexity: 18.8 mm.

Discussion.—This taxon is the probable descendant of *Rebeccapecten trentensis* (Harris, 1919). It is different in that it is larger, heavier ribbed, and more convex. The primary ribs in *R. berryae* do not tend to bifurcate as they do in *R. trentensis*. The somewhat nodose appearance is only slight, and the taxon bears only some resemblance to *Nodipecten*.

Etymology.—The species is named for Rebecca Berry, who worked for the U.S. Geological Survey in 1984–1985.

Type information.—Holotype USNM 405194. Type locality: Silverdale Marl Company Quarry at Silverdale, 0.4 km SE of intersection of Rte. 1434 and Rte. 1442, Onslow County, N.C. (locality 30).

Figured specimen.—Holotype (USNM 405194).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Genus *Carolinapecten*, Ward and Blackwelder, 1987

Carolinapecten urbannaensis (Mansfield, 1929)
Plate 2, figure 4

Pecten eboreus Conrad, 1840, p. 48, Pl. XXIII, fig. 2. [Description in part].

Pecten eboreus urbannaensis Mansfield, 1928*a*, p. 6, Pl. 2, fig. 2, Pl. 3, fig. 2. [Issued January 14, 1929].

Chlamys (*Plagioctenium*) *eboreus urbannaensis* (Mansfield). Tucker-Rowland, 1938, p. 37, Pl. III, figs. 1, 2.

"*Pecten*" *urbannaensis* Mansfield. Ward and Blackwelder, 1980, Pl. 2, fig. 5.

"*Pecten*" *urbannaensis* Mansfield. Ward, 1984, Pl. 10, fig. 6.

"*Pecten*" *urbannaensis* Mansfield. Ward, 1985*b*, Pl. 10, fig. 6.

"*Pecten*" *urbannaensis* Mansfield. Ward, 1985*c*, Pl. 10, fig. 6.

Argopecten eboreus urbannaensis (Mansfield). Gibson, 1987, p. 92, Pl. 11, figs., 1, 3, 4.

"*Pecten*" *urbannaensis* Mansfield. Ward, 1987, p. 137, Pl. 10, fig. 6.

Carolinapecten urbannaensis (Mansfield). Ward, 1989, p. 87, Pl. 10, fig. 6.

Carolinapecten urbannaensis (Mansfield). Ward and Powars, 1989, p. 40, Pl. 14, fig. 6.

"*Pecten*" *urbannaensis* Mansfield. Ward, *in* Johnson et al., 1990, Pl. 10, fig. 6.

Discussion.—This species is common to abundant in the Cobham Bay Member of the Eastover Formation. Small specimens that may be this species occur rarely in the Claremont Manor Member of the Eastover near Claremont, Surry County, Va. Gibson (1987, p. 50) reported the occurrence of *C. urbannaensis* as the "lowermost part of the Yorktown Formation" but the taxon is known only from the Eastover Formation. The *Carolinapecten* lineage appears first in the Eastover Formation (upper Miocene); it proliferated in the Pliocene on the Coastal Plain of North Carolina, South Carolina, Georgia, and Florida, and became extinct in the late Pleistocene. Its associated assemblages indicate its preference for subtropical and tropical marine conditions. Although the temperate taxon *Chesapecten* co-occurs with *Carolinapecten* in some areas, they generally are geographically separated even though it is clear that they occupied the same niche. *Chesapecten* is abundant from the Albemarle Embayment north, and *Carolinapecten* is abundant south of that basin.

Type information.—Lectotype (herein designated): USNM 370829. Type locality: Urbanna, Middlesex County, Va. (USGS 3915). Mansfield's (1928 [1929]) type material consisted of two syntypes, a right and left valve. The herein selected lectotype is the right valve figured on his Plate 2, figure 2.

Figured specimen.—A right valve (USNM 258362) from 0.8 km below Cobham Wharf, right bank of the James River, Surry County, Va. (locality 3, USGS 26052)

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia. Possible occurrence in the Claremont Manor Member of the Eastover Formation (upper Miocene) in Virginia.

Genus *Placopecten* Verrill, 1847

Placopecten princepoides (Emmons, 1858)
Plate 2, figure 3

Pecten princepoides Emmons, 1858, p. 280, fig. 198.
Pecten (Chlamys) clintonius rappahannockensis Mansfield, 1936, p. 186, Pl. 22, figs. 1–3.
Placopecten princepoides (Emmons). Ward and Blackwelder, 1980, Pl. 2, fig. 1.
Placopecten princepoides (Emmons). Ward, 1984, Pl. 10, fig. 1.
Placopecten princepoides (Emmons). Ward, 1985*b*, Pl. 10, fig. 1.
Placopecten princepoides (Emmons). Ward, 1985*c*, Pl. 10, fig. 1.
Placopecten clintonius rappahannockensis (Mansfield). Gibson, 1987, p. 60–62, Pl. 19, figs. 1–6.
Placopecten princepoides (Emmons). Ward, 1987, p. 137, Pl. 10, fig. 1.
Placopecten princepoides (Emmons). Ward, 1989, p. 87, Pl. 10, fig. 1.
Placopecten princepoides (Emmons). Ward and Powars, 1989, p. 40, Pl. 13, fig. 1.
Placopecten princepoides (Emmons). Ward, *in* Johnson et al., 1990, Pl. 10, fig. 1.

Discussion.—*Placopecten princepoides* (Emmons) has long been lost in synonomies of *Placopecten clintonius* (Say) (for example: Gardner, 1943 [1944], p. 37; Dall, 1898*b*, p. 726). I have examined Emmons' type material, now at the Paleontological Research Institution (recently acquired from Williams College), and have concluded that Emmons was describing, however nebulously, the Cobham Bay species later named by Mansfield *Pecten clintonius rappahannockensis*. A trip by the author to the type area indicated by Emmons confirmed that the species is present in large numbers in the Cobham Bay Member of the Eastover Formation in outcrops along the Meherrin River just above Murfreesboro, N.C. The Sunken Meadow Member of the Yorktown Formation (Zone 1 of Mansfield, 1943 [1944]) is also present and contains many specimens of *Placopecten clintonius* (Say). The type material of Emmons, however, contains only specimens from the Cobham Bay Member.

Placopecten princepoides differs from *P. clintonius* in having many more, finer, and impressed rather than raised, radials. Concentric growth lines are strongly impressed and usually result in dislocation of the radial striae when growth resumes. The striae in *P. clintonius* are usually raised, stronger, less crowded, and very continuous and straight. The small radials on *P. clintonius* appear beaded when unworn. Thus the two species are easily separated except when very young or worn.

Type information.—Type: PRI 28289.

Figured specimen.—A right valve (USNM 258359), a topotype specimen from 2.0 km north of the Murfreesboro town limits, right bank of the Meherrin River, Hertford County, N.C. (locality 6, USGS 26053).

Stratigraphic and geographic range.—Eastover Formation (upper Miocene), rare in the Claremont Manor Member, abundant in the Cobham Bay Member in Virginia.

Genus *Eburneopecten* Conrad, 1865

Eburneopecten cerinus (Conrad, 1869)
Plate 20, figure 6

Pecten cerinus Conrad, 1869*c*, p. 39, Pl. 2, fig. 2.
Pecten (Pseudamusium) cerinus Conrad. Dall, 1898*b*, p. 753–754.
Pecten (Pseudamusium) cerinus Conrad. Glenn, 1904, p. 373–374, Pl. XCIX, fig. 2.
Amusium (Pseudamusium) cerinus (Conrad). Tucker-Rowland, 1938, p. 68, Pl. V, fig. 11; Pl. VI, fig. 8.
Amusium (Pseudamusium) cerinus (Conrad). Schoonover, 1941, p. 201.

Discussion.—*Eburneopecten cerinus* (Conrad) is a small, smooth form which is common in Bed 10 of the Plum Point Marl Member of the Calvert Formation. It may be a member of a lineage that started in the Paleocene and is well-represented as late as the late Oligocene in South Carolina. No pectinids of this genus are known in the Miocene to Pliocene beds stratigraphically higher than Bed 10.

Type information.—Types: ANSP 12577. Type locality: "St. Charles Co., Md. Prof. Cope." (Conrad 1869*a*, p. 39). Charles County, Md.

Figured specimen.—Right valve (USNM 405195) from Plum Point, western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland.

Genus *Euvola* Dall, 1898

Euvola smithi (Olsson, 1914)
Plate 2, figure 5

Pecten (Pecten) smithi Olsson, 1914, p. 49, Pl. 4, figs. 1, 2.
Pecten (Pecten) smithi Olsson. Tucker, 1936, p. 480, Pl. 1, fig. 4.

Discussion.—*Euvola smithi* Olsson is present but not abundant in the Cobham Bay Member of the Eastover Formation along the James River in Surry County, Va. A few valves of the taxon have been found in the Sunken Meadow Member of the Yorktown Formation. The right valve is deeply convex with fine lines delineating the weak ribs. The left valve is flat or weakly concave with ribs somewhat more robust.

Type information.—Holotype: PRI 3502. Type locality: Kingsmill Wharf, James City County, Va.

Figured specimen.—Right valve (USNM 405196) from 0.8 km below Cobham Wharf, right bank of the James River, Surry County, Va. (locality 3).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia. Yorktown Formation, Sunken Meadow Member (upper lower Pliocene) in Virginia.

Genus *Pecten* Müller, 1776

Pecten humphreysii Conrad, 1842
Plate 20, figure 4

Pecten humphreysii Conrad, 1842*b*, p. 194, Pl. 2, fig. 2.
Vola humphreysii (Conrad). Conrad, 1863*b*, p. 582.
Vola humphreysii (Conrad). Whitfield, 1894, p. 32–34, Pl. IV, figs. 6–9.
Pecten (*Pecten*) *humphreysii* Conrad. Dall, 1898*b*, p. 720–721.
Pecten (*Pecten*) *humphreysii* Conrad. Glenn, 1904, p. 372, Pl. XCVIII, figs. 10–12.
Pecten (*Pecten*) *humphreysii* Conrad. Tucker, 1936, p. 478, Pl. 3, fig. 3; Pl. 4, fig. 10.
Pecten (*Pecten*) *humphreysii* Conrad. Schoonover, 1941, p. 24–26, Pl. 2, figs. 1–2.
Pecten humphreysii Conrad. Mongin, 1959, p. 297, Pl. 25, figs. 1a–b.
Pecten humphreysii Conrad. Blackwelder and Ward, 1976, p. 42, Pl. 1, fig. 1.
Pecten humphreysii Conrad. Ward, 1984, p. 58, Pl. 7, figs. 1, 3.
Pecten humphreysii Conrad. Ward, 1985*b*, p. 58, Pl. 7, figs. 1, 3.
Pecten humphreysii Conrad. Ward, 1985*c*, Pl. 7, figs. 1, 3.
Pecten humphreysii Conrad. Johnson et al., 1987, p. 134, Pl. 7, figs. 1, 3.
Pecten humphreysii Conrad. Ward, 1989, p. 84, Pl. 77, figs. 1, 3.
Pecten humphreysii Conrad. Ward and Powars, 1989, p. 33, Pl. 7, figs. 1, 3.
Pecten humphreysii Conrad. Ward, 1990, Pl. 7, figs. 1, 3.
Pecten humphreysii humphreysii Conrad. Gibson, 1987, p. 47–49, Pl. 3, figs. 2–7; Pl. 4, figs. 1–8; Pl. 5, figs. 1, 2, 4; Pl. 6, figs. 5, 7.

Discussion.—This well-characterized taxon makes its first appearance in Bed 2 of the Fairhaven Member of the Calvert Formation ("Zone" 2 of Shattuck, 1904). It is known only from molds in that unit but is common and well preserved in Bed 10 ("Zone" 10) of the Plum Point Marl Member. It is not known to occur higher in the section than Bed 10. It occurs in the Pungo River Formation at the Texas Gulf Sulfur quarry at Aurora, Beaufort County, N.C. The southernmost record of the species is from the Torreya Formation of west Florida (Banks and Hunter, 1973). *Pecten humphreysii woolmani* Heilprin, 1888 probably belongs in synonymy with *P. humphreysii*, but the subspecies is based on fragmentary material, making a definite decision on its placement difficult.

Type information.—Neotype: The description and figure that Conrad provided were based on specimens on a "loan" to him from a "Dr. Humphreys of Annapolis." The specimens may have been returned as there is no record of the type material in the Academy of Natural Sciences of Philadelphia. I hereby designate the right valve illustrated herein, Plate 20, figure 4, (USNM 380693), as the neotype. Type locality: Conrad's apparent type locality was "near Fairhaven, Anne Arundel County, Md." The neotype comes from that area but somewhat south of that locality near Plum Point, Calvert County, Md., and was collected by S. F. Blake.

Figured specimens.—Neotype (USNM 380693), a right valve from Plum Point, on the western shore of the Chesapeake Bay, Calvert County, Md., collected by S. F. Blake.

Stratigraphic and geographic range.—Calvert Formation, Fairhaven and Plum Point Marl Members (lower and lower middle Miocene) in Maryland and Virginia; Kirkwood Formation (middle Miocene) of New Jersey; Pungo River Formation (lower and middle Miocene) of North Carolina; Torreya Formation (lower Miocene) of Florida.

Genus *Dimarzipecten*, new genus

Diagnosis.—Valves higher than long, with about 22 thin, irregularly scaled ribs. Small riblets nearly fill interspaces between ribs.

Description.—Cooke's (1919, p. 135) description of *Pecten crocus* characterizes the genus well and is repeated here: "Shell equivalve, inequilateral, moderately convex; about 22 round ribs separated by slight-

ly narrower interspaces; surface of the ribs with curved imbricating spines, convex towards the umbones, and with very faint radiating striae; interspaces with sculpture of fine, close-set, concentric striae; near the ventral margin a small thread appears in each interspace; submargins depressed, ornamented with small radial threads and fine concentric striae; ears moderately large, subequal, with radial, nodose riblets. Alt., 39 mm; lat., 36 mm.; diam., 14 mm."

Discussion.—This taxon has a broad geographic distribution, from the West Indies to North Carolina, and a narrow, known stratigraphic range, the upper Oligocene and lower Miocene. For that reason it is an important marker species for that period. It is desirable, therefore, to give the taxon a generic name for ease of discussion, even though it is the only known species that is assigned to the new genus *Dimarzipecten*. *Dimarzipecten crocus* was originally assigned to the catch-all genus "*Pecten*." *Dimarzipecten* differs in having an only slightly convex right valve and a deeply convex left valve, while the left valve of *Pecten* is flat to concave and the right valve is deeply convex. Other authors, such as Tucker (1934), Rowland (1936), Mansfield (1937), and Richards and Hopkins (1960) placed the species in the genus *Chlamys*. The type of *Chlamys* is *C. islandica* which differs in having far more (averaging 50) thinner, bifurcating ribs, which tend to group in pairs, threes, or fours.

Type information.—Type species: Based on Cooke's (1919) *Pecten crocus*. Type locality: "Roadside, descent to Crocus Bay, Anguilla, station 6893, also 6894 and 6995, Vaughan" (Cooke, 1919, p. 135).

Stratigraphic and geographic range.—Tampa Formation (upper Oligocene and lower Miocene) and its equivalents in Florida and Georgia. Edisto Formation (upper Oligocene and lower Miocene) in South Carolina and Belgrade Formation (upper Oligocene and lower Miocene) in North Carolina.

Dimarzipecten crocus (Cooke, 1919)
Plate 24, figure 2

Pecten crocus Cooke, 1919, p. 135, Pl. 9, fig. 2, a, b; Pl. 11, fig. 9.

Chlamys (*Chlamys*) *crocus* (Cooke). Tucker, 1934, p. 614, Pl. 25, fig. 3.

Chlamys (*Chlamys*) *crocus* (Cooke). Rowland, 1936, p. 1006, Pl. 6, figs. 9, 10.

Chlamys (*Chlamys*) *crocus* (Cooke). Mansfield, 1937, p. 205, Pl. 13, fig. 3.

Chlamys sp. cf. *C. crocus* (Cooke). Richards and Hopkins, 1960, p. 22, Pl. 2, fig. 7.

Discussion.—The two broken specimens that Cooke (1919, p. 132) named *Pecten clevei* probably are the same species as *Dimarzipecten crocus*. *Dimarzipecten crocus* is common in the upper Oligocene and lower Miocene beds from the Caribbean area, Florida, South Carolina, and North Carolina. Its characteristic rib and scale pattern makes it difficult to group with any other known pectinid. It develops a small riblet that nearly fills the interspace between the primary ribs. The scales on the primary ribs are distant but large for the size of the valve. These characteristics and its higher-than-long dimensions serve to distinguish the species. I hesitate to base a genus on a single species, but the taxon is readily distinguishable from any other known pectinid.

Type information.—Holotype: USNM 167079. Type locality: "Roadside, descent to Crocus Bay, Anguilla, station 6893 and 6965, Vaughan" (Cooke, 1919, p. 135).

Figured specimen.—Right valve (USNM 405197) from Silverdale Marl Company Quarry at Silverdale, Onslow County, N.C. (locality 30).

Stratigraphic and geographic range.—Tampa Formation in south Florida and its equivalents in west Florida and Georgia. Edisto Formation in South Carolina. Haywood Landing Member of the Belgrade Formation in North Carolina. All units are upper Oligocene and lower Miocene. West Indies to North Carolina.

Genus *Chesapecten* Ward and Blackwelder, 1975
Subgenus *Chesapecten*, new subgenus
Chesapecten middlesexensis middlesexensis
(Mansfield, 1936)
Plate 2, figure 2

Pecten madisonius var. Mansfield, 1928*a*, p. 10, Pl. 2, fig. 1, Pl. 3, fig. 1. [1929]

Pecten (*Chlamys*) *santamaria middlesexensis* Mansfield, 1936, p. 187, Pl. 22, figs. 5, 6.

Chlamys (*Lyropecten*) *santamaria middlesexensis* (Mansfield). Tucker-Rowland, 1938, Pl. II, fig. 12; Pl. III, fig. 7.

Chlamys (*Lyropecten*) *madisonius richardsi* Tucker-Rowland, 1938, p. 14, Pl. III, figs. 4, 5.

Chesapecten middlesexensis (Mansfield). Ward and Blackwelder, 1975, p. 12, Pl. 5, figs. 1–2; Pl. 7, figs. 4, 11.

Chesapecten middlesexensis (Mansfield). Ward and Blackwelder, 1980, Pl. 2, fig. 6.

Chesapecten middlesexensis (Mansfield). Ward, 1984, p. 63, Pl.

10, fig. 7.

Chesapecten middlesexensis (Mansfield). Ward, 1985*b*, p. 63, Pl. 10, fig. 7.

Chesapecten middlesexensis (Mansfield). Ward, 1985c, Pl. 10, fig. 7.

Chesapecten middlesexensis (Mansfield). Ward, 1987, p. 137, Pl. 10, fig. 7.

Chesapecten middlesexensis (Mansfield). Ward, 1989, p. 87, Pl. 10, fig. 7.

Chesapecten middlesexensis (Mansfield). Ward and Powars, 1989, p. 40, Pl. 14, fig. 7.

Chesapecten middlesexensis (Mansfield). Ward, *in* Johnson, 1990, Pl. 10, fig. 7.

Not—

Chesapecten middlesexensis (Mansfield). Smith, 1991, Pl. 1, fig. 13.

[=*Chesapecten madisonius* (Say, 1824)].

Discussion.—*Chesapecten middlesexensis middlesexensis* differs from C. *jeffersonius* in having more ribs, thinner valves, less inflated valves (especially the right valve), less tight closure along the ventral commissure, a deeper byssal notch, a byssal fasciole which is differentiated from the auricle with respect to sculpture and elevation, and the exterior of the valves covered with moderately coarse scabrous lirae.

Conrad (1863*a*, p. 291) described a pectinid from the Miocene of Virginia and named it *Pecten fraternus*. The diagnosis of this specimen sounds very much like that of *Chesapecten middlesexensis middlesexensis*, but there is no figure, no locality other than Virginia, the type specimen appears to be lost, and the description is not complete enough to make a satisfactory judgment as to the intended taxon. *Pecten fraternus* is therefore considered to be a *nomen dubium*. *Pecten tricarinatus* Conrad (1867) may have been described from the same specimen Conrad used to describe *P. fraternus* Conrad (Heilprin, 1881), but again the identity of the taxon is unclear. *Pecten tricarinatus* is also considered to be a *nomen dubium*.

Chesapecten middlesexensis middlesexensis is most abundant in the Cobham Bay Member of the Eastover Formation, but is present throughout the Eastover Formation.

Type information.—Lectotype: USNM 373074 (Ward and Blackwelder, 1975). Type locality: The river front at Urbanna, Middlesex County, Va., "between the mouth of [Urbanna] Creek and Wharf of Weems line of Steamers on the Rappahannock River, Va."

Figured specimen.—Right valve, a topotype specimen (USNM 258363), from Urbanna Creek, Middlesex County, Va. (USGS locality 25309).

Stratigraphic and geographic range.—Eastover Formation (upper Miocene) of Virginia and North Carolina. Most abundant in the Cobham Bay Member of the Eastover. Specimens have been found as far south as the Neuse River in North Carolina.

Chesapecten (Chesapecten) middlesexensis ceccae, new subspecies

Plate 5, figure 9

Chesapecten middlesexensis (Mansfield). Ward and Blackwelder, 1980, Pl. 1, fig. 12.

Chesapecten middlesexensis (Mansfield). Ward, 1984, p. 63, Pl. 9, fig. 12.

Chesapecten middlesexensis (Mansfield). Ward, 1985*b*, p. 63, Pl. 9, fig. 12.

Chesapecten middlesexensis (Mansfield). Ward, 1985c, Pl. 9, fig. 12.

Chesapecten middlesexensis (Mansfield). Ward, 1987, p. 136, Pl. 9, fig. 12.

Chesapecten middlesexensis (Mansfield). Ward, 1989, p. 86, Pl. 9, fig. 12.

Chesapecten middlesexensis (Mansfield). Ward and Powars, 1989, p. 39, Pl. 13, fig. 12.

Chesapecten middlesexensis (Mansfield). Ward, *in* Johnson et al., 1990, Pl. 9, fig. 12.

Diagnosis.—Large, sub-orbicular valves with moderately large, finely ribbed auricles, averaging 16 small, finely scaled ribs.

Description.—Valves sub-orbicular, moderate in size for the genus, with an average of 16 moderate to small ribs. Ribs and interspaces with numerous small striae. Fine scales produced where concentric growth lamellae intersect the radial striae. Right valve deep for the genus, with moderately large auricles and a deep byssal notch. Byssal fasciole shallow with only two small teeth on the active area of the ctenolium of the holotype. Right valve slightly convex near umbo, becoming more noticeably convex in later growth stages. Left valve very deep with the anterior auricle slightly notched. Interiorly, the valves are thick, with the ribs nearly obscured by the infilling of shell material except near the shell margin. Along the margins, the valves are fluted to correspond to the exterior ribbing. Pallial line is distinct but not impressed. Muscle scar very distinct and deeply impressed on the holotype, as are some of the gill retractor insertions. Resilial insertion deep and triangular.

Discussion. — Valves of *Chesapecten middlesexensis*

ceccae are found in the upper half of the Claremont Manor Member of the Eastover Formation and differ from C. *middlesexensis middlesexensis* in being smaller, finer-ribbed, deeper-valved, and thicker-shelled. The new subspecies may represent an ecophenotypic variation within the C. *middlesexensis middlesexensis* population, but it has distinct characteristics and does not occur with that taxon. *Chesapecten m. ceccae* is abundant in the upper sandy facies of the Claremont Manor Member from Upper Chippokes Creek to Lower Chippokes Creek, both in Surry County, Va.

Type information.—Holotype: USNM 258358. Type locality: 0.8 miles below Sloop Point, just above the mouth of Sunken Meadow Creek, Surry County, Va. (USGS locality 26041).

Figured specimen.—Holotype (USNM 258358).

Stratigraphic and geographic range.—Claremont Manor Member of the Eastover Formation (upper Miocene) in Virginia.

Chesapecten (Chesapecten) santamaria (Tucker, 1934)
Plate 7, figure 4

Pecten (Chlamys) jeffersonius Say. Glenn, 1904, p. 378–379, Pl. C, fig. 2. [Not *Pecten jeffersonius* of Say, 1824].

Chlamys (Lyropecten) santamaria Tucker, 1934, p. 615, Pl. 26, fig. 2.

Chlamys (Lyropecten) santamaria Tucker. Tucker-Rowland, 1938, p. 16–17, Pl. 1, figs. 5, 6; Pl. 2, fig. 10.

Chlamys (Lyropecten) santamaria Tucker. Vokes, 1957, p. 11, Pl. 7, fig. 7.

Chlamys santamaria Tucker. Mongin, 1959, p. 308–309.

Chesapecten santamaria (Tucker). Ward and Blackwelder, 1975, p. 11, Pl. 4, figs. 3–6; Pl. 7, figs. 5, 12.

Chesapecten santamaria (Tucker). Blackwelder and Ward, 1976, p. 44, Pl. 2, fig. 2.

Chesapecten edgecombensis (Conrad). Smith, 1991, Pl. 1, figs. 11, 12.

Discussion.—*Chesapecten santamaria* differs from C. *middlesexensis middlesexensis* in having a less inflated right valve, a deeper byssal notch, broader, flatter ribs, less coarse subradials on the ribs, longer retention of the ctenolium, and a shorter hinge area. It is reasonably clear that C. *santamaria* is a member of a lineage that can be traced back to C. *nefrens* (upper Calvert and Choptank Formations) and whose immediate progenitors can be found in the St. Marys Formation at Langleys Bluff and at Little Cove Point. *Chesapecten santamaria* is found only in the "Windmill Point beds" of the St. Marys Formation. The first *Chesapecten* species to appear in the Claremont Manor Member of the Eastover Formation, C. *middlesexensis middlesexensis*, bears little resemblance to C. *santamaria*, indicating a considerable loss of record or a population shift, or both.

Type information.—Lectotype: USNM 193448, selected by Ward and Blackwelder (1975) (paratype of Tucker, 1934). Type locality: St. Marys River, Md.

Figured specimen.—Right valve (USNM 405198), a topotype specimen from 0.5 km above Windmill Point, right bank of the St. Marys River, St. Marys County, Md. (locality 12). Collected by Thor Hansen, then a student at George Washington University.

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland and Virginia.

Chesapecten (Chesapecten) covepointensis, new species
Plate 11, figures 2, 3, 6

Chesapecten nefrens covepointensis Blackwelder and Ward, 1976, p. 44, Pl. 2, fig. 1. [Figured but not described, *nomen nudem*].

Diagnosis.—Valves medium in size, sub-orbicular, with small auricles, a deep byssal notch, and 17 very scaly ribs radiating from a low beak.

Description.—Valves medium-sized for the genus, nearly orbicular in outline. Auricles small for the size of the disk, reflecting the shorter hinge. Ribs averaging 17, with numerous raised scales both on the ribs and in the interspaces. Three rows of scales on each rib and their interspaces in adult forms. Left valve only slightly convex, right valve even less convex. Byssal fasciole on the right valve moderately deep with two small teeth on the active area of the ctenolium on the holotype (USNM 405199). Right valve with scales better developed and low umbonal area. Beak prominent. Valves very thin with ribs clearly reflected on interior of shell except in umbonal region above the muscle scar. Muscle scar weakly impressed and somewhat posterior to the midline.

Discussion.—This species clearly resembles both *Chesapecten nefrens*, a stratigraphically lower form, and C. *santamaria*, a stratigraphically higher form. The species retains the extremely scaly nature of C. *nefrens* while acquiring the rounded disk outline and smaller auricles of C. *santamaria*. The taxon also has coarser scales than C. *santamaria*. For these reasons C. *covepointensis* appears to be a true intermediate form in an evolutionary continuum. In its type area, Little Cove Point, Calvert County, Md., it is a com-

mon form but never abundant. Many of the valves there are water-worn and were deposited in a shallow inner bay.

Type information.—Holotype: USNM 405199. Type locality: Below Little Cove Point, western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Figured specimens.—Plate 11, figure 2: Holotype, USNM 405199 from the type locality; Plate 11, figure 3: A right valve (USNM 405201) from the same locality; Plate 11, figure 6: Paratype (USNM 405200), a left valve from the same locality.

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland.

Chesapecten (Chesapecten) nefrens
Ward and Blackwelder, 1975
Plate 15, figure 4; Plate 16, figure 2

Pecten madisonius Say. Conrad, 1840, p. 48, Pl. 24, fig. 1. [Not *P. madisonius* Say, 1824, p. 134].
Pecten madisonius Say. Conrad, 1863*b*, p. 581.
Pecten madisonius Say. Whitfield, 1894, p. 30, Pl. 4, fig. 5.
Pecten (*Chlamys*) *madisonius* Say. Glenn, 1904, p. 377, Pl. C, fig. 1.
Pecten (*Chlamys*) *madisonius* Say. Grabau and Shimer, 1909, p. 502, fig. 673C.
Pecten (*Chlamys*) *madisonius* Say. Mansfield, 1936, p. 174, 176, 177, 184.
Chlamys (*Lyropecten*) *madisonius* (Say). Tucker-Rowland, 1938, p. 9–11, Pl. 1, figs. 1, 2.
Chlamys (*Lyropecten*) *madisonius* (Say). Schoonover, 1941, p. 28–37, Pl. 3, figs. 1–3; Pl. 4, fig. 4; Pl. 5, fig. 3.
Chlamys (*Lyropecten*) *madisonia* (Say). Gardner, 1943 [1944], p. 32, Pl. 4, fig. 5; Pl. 9, fig. 7.
Chlamys (*Lyropecten*) *madisonius* (Say). Vokes, 1957, p. 10, Pl. 7, fig. 6.
Chlamys madisonia (Say). Mongin, 1959, p. 309, Pl. 26, figs. 1, 2.
Chesapecten nefrens Ward and Blackwelder, 1975, p. 9, Pl. 2, figs. 4–6; Pl. 3, figs. 4–7; Pl. 4, figs. 1, 2; Pl. 7, figs. 6, 13.
Chesapecten nefrens Ward and Blackwelder. Gibson, 1987, p. 76–77, Pl. 31, fig. 7.
Chesapecten nefrens Ward and Blackwelder. Ward and Powars, 1989, p. 34, Pl. 8, fig. 2.

Discussion.—*Chesapecten nefrens* differs from *C. covepointensis* and *C. santamaria*, both in the St. Marys Formation, in having narrower, unflattened ribs, larger gapes between disk flanks, larger gapes along the ventral commissures, coarser scabrous lirae, a larger byssal notch, and larger auricles. Specimens of *C. nefrens* that occur stratigraphically from Bed 14 ("Zone" 14 of Shattuck, 1904) through Bed 17 ("Zone" 17, the Drumcliff Member of the Choptank Formation) and Bed 18 ("Zone" 18, the St. Leonard Member of the Choptank Formation) are somewhat narrower in disk outline than *C. nefrens* from Bed 19 ("Zone" 19, Boston Cliff Member of the Choptank Formation). Adult specimens from the Boston Cliffs Member, from which the holotype came, are markedly elongate and have a correspondingly long hinge and wide auricles. The earlier forms of *C. nefrens*, in the Calvert Beach (Calvert Formation) and Drumcliff Members, are more ovate and possess proportionately smaller auricles. This difference may only be ecophenotypic but it is consistent enough to be of biostratigraphic value.

Type information.—Holotype: USNM 199442. Type locality: Boston Cliffs Member (Bed 19) at Camp Conoy below the Baltimore Gas and Electric Atomic Power Plant, Calvert County, Md. (USGS locality 25299).

Figured specimens.—Plate 15, figure 4: Holotype (USNM 193442) from the type locality. Plate 16, figure 2: Right valve (USNM 405202) from Drumcliff on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—The usual form of *C. nefrens* occurs stratigraphically from Beds 14 (Calvert Beach Member of the Calvert Formation) (lower middle Miocene) to 19 (Boston Cliffs Member) (upper middle Miocene) of the Choptank Formation. Several species of *Chesapecten* in Bed 10 of the Calvert Formation (lower middle Miocene) appear to be closely related but never attain the size of the normal adults in the upper Calvert and Choptank Formations. *Chesapecten nefrens* occurs in the Calvert and Choptank Formations in Maryland and Virginia. In Virginia, *C. nefrens* is found in the Calvert Beach Member and the Boston Cliffs Member at the Nomini Bluffs on the Potomac River, Westmoreland County and in the Calvert Beach Member at Fones Cliffs on the Rappahannock River, Richmond County.

Chesapecten (Chesapecten) monicae, new species
Plate 14, figures 1–6

Diagnosis.—Small, orbicular valves with 10–13 very finely striated ribs. Scales very small to obsolete.

Description.—Valve small, thin with 10–13 ribs. Ribs somewhat distant, flattened and exhibiting only a trace of scaling patterns to the unaided eye. Very

fine striations radiating from the low umbones are evident on the ribs and their interspaces under moderate magnification. Ribs developing three lines of very subdued scales. Ribs low, flat and wide medially, becoming thin anteriorly and posteriorly. Auricles with smooth striae radiating from beak. Valve moderately convex. Interiorly, ribs flat and sharply defined to correspond with exterior sculpture. Ribs obscured in beak area. Ligamental pit small and triangular.

Measurements (in millimeters).—

Measured specimen	valve	height	length	width
Holotype (USNM 405204)	LV	32.8	32.6	5.9
Paratype (USNM 405207)	LV	18.8	18.6	3.2
Paratype (USNM 405206)	RV	31.7	31.3	4.9
Paratype (USNM 405205)	LV	33.6	33.5	5.5

Discussion.—This taxon is based on four individuals. Because of their small size they are easily confused with the young of *Chesapecten nefrens*. They differ in having fewer ribs and more subdued scaling patterns. The young of C. *nefrens* have, at a similar size, fully defined rows of scabrous lirae on the auricles and the ribs. It is possible that C. *monicae* represents a small offshoot from the *Chesapecten* lineage in the upper middle Miocene. The species is named in honor of Monica Genadio, who worked for the U.S. Geological Survey in 1983-1984.

Type information.—Holotype: USNM 405204. Type locality: Boston Cliffs Member of the Choptank Formation, just below Flag Pond and just north of the Baltimore Gas and Electric Power Plant, Calvert County, Md. (locality 17).

Figured specimens.—Plate 14, figure 1: holotype (USNM 405204); Plate 14, figures 2, 5: paratype, USNM 405205; Plate 14, figures 3, 6: Paratype, USNM 405206; Plate 14, figure 4: paratype, USNM 405207.

Stratigraphic and geographic range.—Choptank Formation, Boston Cliffs Member (upper middle Miocene) in Maryland. Known only from the type locality in Calvert County, Md.

Chesapecten (Chesapecten) coccymelus (Dall, 1898)
Plate 20, figures 1, 3

Pecten (Chlamys) coccymelus Dall, 1898*b*, p. 741–742, Pl. 34, fig. 1.

Pecten (Chlamys) coccymelus Dall. Glenn, 1904, p. 374–375, Pl. 99, fig. 3.

Chlamys (Chlamys) coccymelus (Dall). Rowland, 1936, p. 1007–1008, Pl. 8, figs. 3, 4.

Chlamys (Lyropecten) madisonius bassleri Tucker-Rowland, 1938, p. 13–14, Pl. 5, fig. 1.

Chesapecten coccymelus (Dall). Ward and Blackwelder, 1975, p. 8, Pl. 3, figs. 1, 2; Pl. 7, figs. 14, 15.

Chesapecten coccymelus (Dall). Gibson, 1987, p. 74–76, Pl. 27, figs. 1–6; Pl. 28, figs. 1–5; Pl. 29, figs. 1–5; Pl. 30, figs. 1–5.

Chesapecten coccymelus (Dall). Carter et al., 1988, p. 84, Pl. 8, fig. 62.

Discussion.—*Chesapecten coccymelus* is a small *Chesapecten*, usually less than 60 mm in height, having very high distally concave spines and unequal auricles, the anterior auricle being longer than the posterior.

Plicae of right valve number 15–19, each plica strongly sculptured with one to three rows of very high distally concave spines and with one to three rows of less elevated spines in the interspaces.

Chesapecten coccymelus differs from C. *nefrens* in being smaller (average adults being only 40–50 mm long, as opposed to 150 mm for C. *nefrens*), in its rows of very high distally concave spines, and in its unequal auricle size, the anterior auricle being longer than the posterior.

Dall's original specimen is an end member of a somewhat variable species. A comparison of the holotype and other specimens shows that the number of rows of spines on the ribs is a variable character. This species is common in Bed 10 of the Plum Point Marl Member of the Calvert Formation.

Mongin (1959) suggested that a new name, *calvertensis*, be applied to several species, including C. *bassleri* (Tucker-Rowland). The name *calvertensis* does not have priority and cannot be used. In addition, the species intended to be grouped under that name do not appear to be closely related.

Type information.—Holotype: USNM 87754. Type locality: Plum Point, Md.

Figured specimen.—Plate 20, figure 1: Right valve (USNM 405208) from 0.5 miles below Camp Roosevelt, western shore of the Chesapeake Bay, Calvert County, Md.; Plate 20, figure 3: Left valve (USNM 405209) from the same locality.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland. Pungo River Formation (lower middle Miocene) in North Carolina.

Chesapecten(?) skiptonensis (Mansfield, 1936)
Plate 18, figures 5, 8

Pecten (Nodipecten) Rogersi Conrad. Dall, 1898*b*, p. 730. [In part; not *P. rogersi* of Conrad, 1834].

Pecten (*Chlamys*) *rogersi* Conrad. Glenn, 1904, p. 375, Pl. XCIX, fig. 4. [Not *P. rogersi* of Conrad, 1834].

Pecten (*Chlamys*) *skiptonensis* Mansfield, 1936, p. 186, Pl. 23, fig. 12.

Chlamys (*Chlamys*) *rogersi* (Conrad). Rowland, 1936, p. 1008, Pl. 7, fig. 9. [In part *P. rogersi* Conrad, 1834; Pl. 7, fig. 9 is *P. skiptonensis* Mansfield, 1936].

Chlamys (*Lyropecten*) *skiptonensis* (Mansfield). Tucker-Rowland, 1938, p. 8, fig. 23.

Discussion.—The immature specimen that is the holotype of *Chesapecten*(?) *skiptonensis* Mansfield was found in Talbot County on the Eastern Shore of Maryland and was assigned to *Pecten rogersi* Conrad by Dall (1898*b*), Glenn (1904), and Rowland (1936). It superficially resembles "*P.*" *rogersi* in that they both have a few wide ribs, but differs from it in its radial sculpture, shell structure, rib shape, and disk margins. "*P.*" *rogersi* is known to occur only in the Rushmere Member of the Yorktown Formation (upper Pliocene) in Virginia. The specimen that Mansfield used for a holotype (USNM 143658) was an immature individual, only 10 mm in height, but he considered it distinct enough, even at that stage, to be separable from "*P.*" *rogersi* Conrad. The specimen figured here is a somewhat more mature individual collected in 1919 by William Palmer from Bed 14 ("Zone" 14) in the Calvert Formation south of Chesapeake Beach, Calvert County, Md. The figured specimen is a right valve, small (height 39 mm, length 36.4 mm, width 5.3 mm), slightly higher than long, with 6 pronounced ribs with wider interspaces. Anterior and posterior ribs small, the other four large and flat. Very feeble development of 3 radial lirae on the ribs up to a height of 10 mm. After that stage, 7–9 slightly more prominent, but still subdued, radial lirae develop on the ribs and the interareas. Fine, platelike incrementals may be seen in concentric rows between the lirae. The ribs show a somewhat interrupted pattern in that they change direction to form a very slight zigzag pattern. This feature is reminiscent of *Nodipecten*, but only low undulations can be seen, not distinct nodes. Auricles large with deep byssal notch. Fine scabrous lirae radiating from the beak. Byssal fasciole narrow and deep. Four very small teeth on the active ctenolium. Interior of valve deeply ribbed to notch exterior sculpture. Valve relatively shallow. Muscle attachment area partly broken and not distinct.

In general outline and rib numbers, C.(?) *skiptonensis* resembles *Anatipopecten*, but the auricles are distinctly sharper in that taxon. Until sufficient numbers of C.(?) *skiptonensis* are found, its true taxonomic placement will be in question.

Type information.—Holotype: USNM 143658. Type locality: Near Skipton, Talbot County, Md. (USGS locality 2366).

Figured specimen.—Right valve (USNM 405210), from Bed 14 of the Calvert Beach Member of the Calvert Formation, just downbay of Chesapeake Beach, western shore of the Chesapeake Bay, Calvert County, Md. Collected by William Palmer, July 1919.

Stratigraphic and geographic range.—Exact stratigraphic position for the holotype is unknown but is probably the same as the figured specimen: Calvert Formation, Calvert Beach Member, Bed 14 (lower middle Miocene) in Maryland. It is known only from Calvert and Talbot Counties, Md.

Subgenus *Christinapecten*, new subgenus

Diagnosis.—Subequivalved, both valves convex, the left deeper than the right. Sculpture consists of 20 small ribs which bifurcate at an early stage. A single riblet appears in the interstices and becomes nearly as prominent as the primary ribs. Auricles large, scaly, with a deep byssal notch.

Description.—Subequivalved, both valves convex, with the right valve slightly convex, and the left moderately so, especially in the umbonal area. Disk outline nearly ovate, with large auricles. Right valve with small posterior auricle and large anterior one with deep byssal notch. Byssal fasciole sharply defined with five (in the type species) denticles prominent in the active ctenolium. Left valve with small, sloped posterior auricle and a larger anterior one with a small byssal sinus. Exterior sculpture consists of twenty small ribs radiating from a sharp beak. Ribs bifurcate when disk approximately 10 mm in height to form two small, smooth riblets. A single riblet appears in the interstices at the same stage and becomes nearly as prominent as the primary ribs. Other very small subordinate riblets appear in interstices at late growth stage. Radial sculpture consists of very small, plate-like incrementals between the riblets. Interiorly, the valves marked by very shallow ribs, which reflect the exterior inter-rib areas, and which are obscured in the upper one-half of the valves. Ligamental pit small and triangular. Muscle scars weakly impressed and indistinct.

Discussion. — This taxon is based on *Chesapecten*

(*Christinapecten*) *marylandica*, which is common in the Drumcliff Member of the Choptank Formation. It has been treated as a species of *Placopecten* but is distinctly different from that genus in its ribbing, shell outline, auricles, and shell structure. More recently Glibert and van de Poel (1965) placed it in the genus *Mimachlamys*, a Tasmanian form, but that taxon is strongly ribbed and covered with prominent scales. *Christinapecten* has the distinct outline and prominent auricles of *Chesapecten*, but it is distinguished by fine bifurcating ribs and interradials that are nearly devoid of scaling. *Christinapecten* consistently has more ribs than *Chesapecten sensu stricto*, having 20 primary ribs, whereas *Chesapecten* has between 13 and 17. The first forms of this subgenus are known from Bed 10 ("Zone" 10 of Shattuck, 1904) of the Plum Point Marl Member of the Calvert Formation and are unnamed. They differ from C. (C.) *marylandica* in having three small riblets on the primary ribs instead of two but in other respects are very similar.

Type information.—Type species: Based on *Pecten marylandicus* Wagner, 1839, the neotype of which is USNM 405211.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland; Calvert Beach Member (lower middle Miocene) in Maryland and Virginia. Choptank Formation, Drumcliff Member, Bed 17 (middle middle Miocene) in Maryland.

Chesapecten (*Christinapecten*) *marylandica*
(Wagner, 1939)
Plate 16, figure 1

Pecten marylandicus Wagner, 1839, p. 51, Pl. 1, fig. 2.
Pecten (*Placopecten?*) *marylandicus* Wagner. Dall, 1898*b*, p. 728.
Pecten (*Chlamys*) *marylandicus* Wagner. Glenn, 1904, p. 376–377, Pl. XCIX, fig. 6.
Chlamys (*Placopecten*) *marylandicus* (Wagner). Tucker-Rowland, 1938, p. 54–55, Pl. IV, fig. 13; Pl. V, fig. 16.
Chlamys (*Placopecten*) *marylandicus* (Wagner). Schoonover, 1941, p. 190–192, Pl. 3, figs. 4, 5.
Pecten (*Placopecten*) *marylandica* (Wagner). Gardner, 1943 [1944], p. 38, Pl. 5, fig. 4; Pl. 6, figs. 2, 3.
Pecten (*Placopecten*) *marylandicus* (Wagner). Vokes, 1957, p. 11, Pl. 7, fig. 5.
Chlamys (*Placopecten*) *marylandica* (Wagner). Mongin, 1959, p. 300–301.
Mimachlamys marylandica (Wagner). Glibert and van de Poel, 1965, p. 32.
Chesapecten maylandica Wagner. Ward and Powars, 1989, p. 34, Pl. 8, fig. 1.

Discussion.—Some specimens of *Chesapecten* (*Christinapecten*) *marylandica* appear to intergrade with specimens of *Chesapecten (Chesapecten) nefrens* with which it co-occurs, but close inspection makes the two separable on the basis of rib numbers and shape as well as scaling patterns. *Chesapecten* (C.) *marylandica* has scaly auricles but lacks scales on the disk except on the most anterior and/or most posterior ribs. The habit of bifurcation of ribs produces a very uniformly fine radial sculpture that is easily recognized.

Pecten marylandicus was named by Wagner (1839) and was reported to have come from the "Mehering river, North Carolina." Valves of "*Pecten*" *decemnaria* which are similar to *Chesapecten* (*Christinapecten*) *marylandica*, but belong to another distinct lineage, are present in the Rushmere Member of the Yorktown Formation at Murfreesboro, N.C., in exposures along the Meherrin River. They are easily distinguished from the C. (C.) *marylandica* because they lack the "smooth striae, disposed in pairs" and "interstitial spaces each with a carinated line" that Wagner described (1839, p. 51). It is immediately suspicious, but not impossible, that Wagner meant to name a North Carolina pectinid "marylandica." The remainder of the taxa described by Wagner could have all come from the Choptank River on the Patuxent River, St. Marys County, Md., and indeed one, *Trochus eboreus*, was described from there. I believe that C. (C.) *marylandica* did, in fact, come from that locality in Maryland. The whereabouts of Wagner's type material is unknown, and I herein designate the specimen illustrated on Plate 16, figure 1 (USNM 405211), as the neotype.

Type information.—Neotype: USNM 405211. Type locality: Drumcliff Member of the Choptank Formation at Drumcliff (Jones Wharf) on the Patuxent River, St. Marys County, Md. Probably the type locality.

Figured specimen.—Neotype (USNM 405211) from Drumcliff (Jones Wharf) on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Choptank Formation, Drumcliff Member (Bed 17) (middle middle Miocene) in Maryland. Calvert Formation, Calvert Beach Member (lower middle Miocene) in Maryland and Virginia.

Superfamily ANOMIOIDEA Rafinesque, 1815
Family ANOMIIDAE Rafinesque, 1815
Genus *Anomia* Linné, 1758

Anomia ruffini Conrad, 1843
Plate 24, figure 12

Anomia ruffini Conrad, 1843*b*, p. 323. [USNM copy has handwritten note "Jan. 19, 1844"].
Anomia ruffini Conrad. Conrad, 1845, p. 74, Pl. 42, fig. 6.
Anomia ruffini Conrad. Conrad, 1863*b*, p. 582.
Anomia mcgeei Clark, 1895, p. 5.
Anomia mcgeei Clark. Clark, 1896, p. 86, Pl. XXXIV, figs. 5a, 5b.
Anomia ruffini Conrad. Dall, 1898*b*, p. 782.
Anomia mcgeei Clark. Clark and Martin, 1901, p. 187, Pl. XLIV, fig. 1.
Anomia onslowensis Richards, 1943, p. 520, Pl. 84, figs. 10, 11.
Anomia ruffini Conrad. Ward, 1984, p. 55, Pl. 6, fig. 4.

Discussion.—This taxon was first described by Conrad (1843*b*) from specimens given him by Edmund Ruffin from New Kent County, Va. That locality has not been relocated, but Ward (1984) reported a new locality nearby, 2.3 km south of Bottoms Bridge, in Henrico County, Va. (Ward, 1984, p. 254–255). Clark (1895) thought that his specimens were of Eocene age and therefore different from Conrad's Miocene taxon. As a result Clark named the same species *A. mcgeei*. Richards (1943) gave a third name to the taxon based on specimens found in equivalent beds in North Carolina in the Haywood Landing Member of the Belgrade Formation (Ward et al., 1978).

Type information.—Type: ANSP, no catalogue number. Type locality: "Pamunkey River, Kent County, Virginia" (Conrad, 1843*b*, p. 323).

Figured specimen.—Left valve (USNM 405212), from the Silverdale Marl Company Quarry at Silverdale, from Onslow County, N.C. (locality 30).

Stratigraphic and geographic range.—Old Church Formation (upper Oligocene and lower Miocene) in Virginia. Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Suborder OSTREINA Férussac, 1822
Superfamily OSTREOIDEA Rafinesque, 1815
Family GRYPHAEIDAE Vyalov, 1936
Subfamily PYCNODONTINAE Stenzel, 1959
Genus *Pycnodonte* Fischer de Waldheim, 1835

Pycnodonte percrassa (Conrad, 1840)
Plate 21, figure 3

Ostrea percrassa Conrad, 1840, p. 50, Pl. XXV, fig. 1.
Ostrea percrassa Conrad. Conrad, 1863*b*, p. 582.
Ostrea percrassa Conrad. Heilprin, 1884*a*, p. 313, Pl. LXVII, fig. 3.
Ostrea percrassa Conrad. Whitfield, 1894, p. 29–30, Pl. III, figs. 1–4.
Ostrea percrassa Conrad. Dall, 1898*b*, p. 683. [In part].
Ostrea percrassa Conrad. Glenn, 1904, p. 382, Pl. CII, fig. 1, 2.
Ostrea percrassa Conrad. Richards and Harbison, 1942, p. 188, Pl. 9, figs. 1, 3.
Ostrea percrassa Conrad. Vokes, 1957, p. 10, Pl. 6, fig. 3.
Pycnodonte percrassa (Conrad). Glibert and van de Poel, 1965, p. 68.

Discussion.—*Pycnodonte percrassa* (Conrad) is abundant along the unconformable contact between the Fairhaven and Plum Point Marl Members of the Calvert Formation in Calvert and Prince Georges Counties, Md. A thinner, less robust, but otherwise identical form of *P. percrassa* is found in Bed 10 ("Zone" 10 of Shattuck, 1904) of the Plum Point Marl Member at Hollin Cliffs on the Patuxent River, Calvert County, Md. The taxon is also known from the Kirkwood Formation at Stow Creek, Cumberland County, N.J., and the Pungo River Formation at the Texas Gulf Sulfur mine at Aurora, Beaufort County, N.C.

Type information.—Lectotype: ANSP 14024. Type locality: Stow Creek, Cumberland County, N.J. Conrad's type lot consists of six valves with the catalogue number 14024 and one valve with the catalogue number 17151. Conrad's figured specimen (Conrad, 1840, Pl. XXV, fig. 1) (ANSP 14024) is here designated the lectotype.

Figured specimen.—Left valve (USNM 405213) from Bed 10 of the Plum Point Marl Member of the Calvert Formation at Holland Cliff, on the Patuxent River, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member (lower and lower middle Miocene) in Maryland; Kirkwood Formation (lower and lower middle Miocene) in New Jersey; Pungo River Formation (lower? and lower middle Miocene) in North Carolina.

Genus *Hyotissa* Stenzel, 1971

Hyotissa haitensis (Sowerby, 1850)
Plate 20, figures 7, 8

Ostrea haitensis Sowerby, 1850, p. 53.
Ostrea haitensis Sowerby. Dall, 1898*b*, p. 685.
Ostrea haitensis Sowerby. Gardner 1926*a*, p. 42.
Ostrea haitensis Sowerby. Tucker and Wilson, 1932, p. 42.
Pycnodonta haitensis (Sowerby). Olsson and Petit, 1964, p. 531, Pl. 78, fig. 7.
Pycnodonte (*Alectryonella*) *haitensis* (Sowerby). Glibert and van de Poel, 1965, p. 69.
Hyotissa haitensis (Sowerby). Woodring, 1982, p. 607–610.

Discussion.—Woodring (1982) exhaustively described and discussed this taxon, so no further description is included here. The specimens examined from Bed 10 of the Plum Point Marl Member of the Calvert Formation are not as regularly ribbed as those described by the authors mentioned in the synonomy. Some of the Calvert specimens had no ribs; others had from one to eight. Much of this variation is believed to be due to crowding and other ecological factors. The genus and the species are known principally in subtropical to tropical settings, and their presence in the Miocene of the Salisbury Embayment is considered to be evidence of similar conditions there at that time.

Type informationn.—Type: BM(NH) LL11353: Type locality: Valley of Rio Yaque del Norte, Dominican Republic.

Figured specimen.—Left valve (USNM 405214) from Bed 10 ("Zone" 10 of Shattuck, 1904) at Plum Point, western shore of the Chesapeake Bay, Calvert County, Md. Specimen was collected by S. F. Blake, probably from the bluff immediately south of Plum Point.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland. Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina. Edisto Formation (upper Oligocene and lower Miocene) in South Carolina. Tampa Limestone (upper Oligocene and lower Miocene) in south Florida. Chipola Formation (lower Miocene) in Florida. Shoal River Formation (middle Miocene) in Florida. Woodring (1982) gives the range and age of this taxon in the Caribbean area.

Superfamily OSTREOIDEA Rafinesque, 1815
Family OSTREIDAE Rafinesque, 1815
Subfamily OSTREINAE Rafinesque, 1815
Genus *Crassostrea* Sacco, 1897

Crassostrea sp.
Plate 7, figures 1, 3

Description.—Shell of moderate size for the genus, sub-trigonal in outline when uncrowded, very irregular in shape when crowded. Left valve deeply convex, right valve flat to slighty convex. Exterior of left valve irregularly and finely lamellate, giving a weakly ribbed appearance. Right valve smooth except for closely spaced, fine, concentric growth lines. Left valve with a large hinge area, triangular in outline and inclined posteriorly. Resilifer well-defined but shallow. Very small relict catachomata visible in the hinge area. Muscle scar large, lunate and slightly buttressed. Interior margin of valve smooth.

Discussion.—This taxon is scarce to common but never abundant in the Windmill Point beds of the St. Marys Formation. Most of the specimens are worn, and several are very irregular in outline. The taxon clearly seems to be a *Crassostrea* and not a worn *Ostrea* because of its deep-valved, elongate shape and lack of strong catachomata. It is known only from the Windmill Point in Maryland and Virginia.

Figured specimen.—Left valve (USNM 405215) from the Windmill Point beds of the St. Marys Formation, Essex Millpond, Essex County, Va. (locality 14).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds, Bed 24 ("Zone" 24 of Shattuck, 1904) (lower upper Miocene) in Maryland and Virginia.

Genus *Ostrea* Linné, 1758

Ostrea compressirostra geraldjohnsoni, new subspecies
Plate 2, figure 1

Ostrea compressirostra (Say). Ward and Blackwelder, 1980, Pl. 3, fig. 7.
Ostrea compressirostra (Say). Ward, 1984, Pl. 11, fig. 7.
Ostrea compressirostra (Say). Ward, 1985*b*, Pl. 11, fig. 7.
Ostrea compressirostra (Say). Ward, 1985*c*, Pl. 11, fig. 7.
Ostrea compressirostra (Say). Ward, 1987, p. 138, Pl. 11, fig. 7.
Ostrea compressirostra (Say). Ward, 1989, p. 88, Pl. 11, fig. 7.
Ostrea compressirostra (Say). Ward and Powars, 1989, p. 41, Pl. 15, fig. 7.
Ostrea compressirostra (Say). Ward, *in* Johnson et al., 1990, p.

11, fig. 7.

Diagnosis.—Shell large, moderately thick, inequivalved, with deep left valve, exteriorly ornamented with nearly continuous undulating, raised concentric lamellae, and nearly smooth flat right valve with fine concentric lines.

Description.—Left valve deeply convex, subovate in outline with numerous wrinkled, raised concentric lamellae giving a very scaly appearance. Numerous, somewhat discontinuous, radiating ribs, usually terminating at the lamellae with a small fold. A moderately large fold on the posterior margin marking the exhalent sulcus. Left valve with small, sinuous beak, reflected posteriorly, with a triangular, well-defined ligamental area. Valve interiorly capacious with a large, lunate, posterior adductor muscle scar somewhat posterior of central. Other muscle scars indistinct and chomata osolete. Margin of the valve smooth. Description of right valve based on specimens other than the type; valve ovate, flat to slightly convex, somewhat undulant exteriorly with numerous fine concentric lines. Some small anachomata apparent. Valve margin smooth.

Measurements of the holotype (USNM 258370): Length: 90.1 mm, height: 106.8 mm, width: 35.9 mm.

Discussion.—*Ostrea compressirostra geraldjohnsoni* differs from both *O. compressirostra brucei* and *O. compressirostra compressirostra* in having a deeper left valve and a more scaly appearance due to the extremely crowded wrinkles along the acutely raised lamellae. The new subspecies is clearly related to and is the probable precursor of *O. compressirostra* but lacks the development of the auricles of that taxon. In addition, *O. c. geraldjohnsoni* has a much less profound posterior exhalant fold than *O. compressirostra*.

Etymology.—*Ostrea c. geraldjohnsoni* is named in honor of Dr. G. H. Johnson of the Geology Department at the College of William and Mary.

Type information.—Holotype: USNM 258370. Type locality: 0.8 km downriver from Cobham Wharf, right bank of the James River, Surry County, Va. (locality 3).

Figured specimen.—Holotype (USNM 258370).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Ostrea compressirostra brucei, new species

Plate 5, figure 8

Ostrea sp. Ward and Blackwelder, 1980, Pl. 1, fig. 10.
Ostrea sp. Ward, 1984, Pl. 9, fig. 10.
Ostrea sp. Ward, 1985*b*, Pl. 9, fig. 10.
Ostrea sp. Ward, 1985*c*, Pl. 9, fig. 10.
Ostrea sp. Ward, 1987, p. 136, Pl. 9, fig. 10.
Ostrea sp. Ward, 1989, p. 86, Pl. 9, fig. 10.
Ostrea sp. Ward, *in* Johnson et al., 1990, Pl. 9, fig. 10.

Diagnosis.—Shell large, thick, inequivalved, with a deep left valve externally ornamented by numerous, small, nearly continuous ribs. Right valve nearly flat, with fine concentric lines.

Description.—Left valve moderately convex, subovate in outline, with numerous fine ribs interrupted by low, concentric growth lamellae, giving a finely scaly appearance. Ribs small, somewhat discontinuous, and interrupted at the lamellae by a small fold. A slight fold on the posterior margin marks the exhalent sulcus. Left valve with a small sinuous beak, reflected posteriorly, with a triangular, weakly defined ligamental area. Left valve interiorly moderately capacious with a large, lunate, posterior adductor muscle scar somewhat posterior of central. Other muscle scars indistinct and chomata weakly visible on the upper one-fifth of the shell. Ventral margin somewhat sinuous but smooth. Left valve larger than the nearly flat right valve.

Description of the right valve based on specimens other than the holotype; valve elongate to ovate, flat to slightly concave, with numerous, fine, concentric growth lines. Ligamental area nearly flat with resilifer triangular, clearly crossed by growth lines, and very slightly depressed. Ventral border of resilifer slightly buttressed. Relict anachomata apparent only adjacent to the ligamental area. Margin of valve smooth. Muscle scar lunate, postero-ventral in placement, and well-defined.

Discussion.—*Ostrea compressirostra brucei* is the first known member of a lineage, which becomes abundant in the late Miocene, thrives in the early Pliocene, survives the post-Yorktown cooling event, and makes its last known appearance in the Chowan River Formation (upper Pliocene). *Ostrea compressirostra brucei*, which occurs in the Claremont Manor Member, differs from *O. compressirostra geraldjohnsoni* in having more ribs and finer ribs, which gives it a much less scaly appearance. In addition, the left valve of *O. c. brucei* is not as deep as that of *O. c. geraldjohnsoni*.

Ostrea compressirostra compressirostra from the Sunken Meadow Member of the Yorktown Formation is also much more scaly than *O. c. brucei* and exhibits well-developed auricles. The succeeding species, *O. compressirostra raveneli*, which is found in the upper Yorktown (Rushmere, Morgarts Beach, Moore House Members), somewhat resembles *O. c. brucei* but the ribbing in the left valve of *O. c. raveneli* is much less regular and coarser.

Etymology.—*Ostrea c. brucei* is named in honor of Scott Bruce of the Virginia State Water Control Board, who has assisted the author on innumerable field trips.

Type information.—Holotype (USNM 258356). Type locality: Just above the mouth of Sunken Meadow Creek on the James River, Surry County, Va. (USGS locality 26041), in the Claremont Manor Member of the Eastover Formation.

Figured specimen.—Holotype, USNM 258356.

Stratigraphic and geographic range.—Eastover Formation, Claremont Manor Member (upper Miocene) in Virginia.

Genus *Conradostrea* Ward and Blackwelder, 1987

Discussion.—*Conradostrea* is a small, plicate oyster that is variable in form. In this and its lack of small, marginal tubercles it differs from the genus *Lopha* Roding. It is strikingly different from other Miocene-Pliocene ostreid taxa in its subtrigonal to sub-falcate form and its profound and often scaley ribs. The genus makes its first appearance in the Cobham Bay Member of the Eastover Formation with the species *Conradostrea greeni*, n. sp., a diminutive form. No representatives of the genus are present in the Sunken Meadow Member of the Yorktown, presumably because the genus preferred warm-temperate to subtropical conditions and that unit reflects cool temperate conditions. The genus is represented in the upper Yorktown by *C. sculpturata* and in the James City Formation (upper Pliocene and lower Pleistocene) by *C. lawrencei* (Ward and Blackwelder's genotype). The genus apparently becomes extinct after a cooling event in the early Pleistocene, and no living representatives are known.

Conradostrea greeni, new species
Plate 1, figures 7, 9

Diagnosis.—Shell small, trigonal, with numerous irregular radial plications.

Description.—Shell small, thick for its size, triangular with sharply angular beak and rounded anterior and ventral margin. Valves slightly unequal in size, the left valve being slightly deeper. The left valve commonly attached. When not attached, exterior sculpture consists of weak, somewhat discontinuous ribs. Small concentric lamellae mark growth increments. Ribs sometimes entirely absent on young shell, most developed on lower half of adult. Plications occasionally reflected on the anterior and posterior margins as well as the ventral margin. Interiorly, resilifer narrow and sinuous, chomata small but well defined, adductor muscle scar lunate and placed anteriorly. Exterior ribs obscured on the interior but weakly reflected along the shell margins.

Measurements.—Holotype (USNM 405216): 26.7 mm in height and 24.0 mm in length. Paratype (USNM 405217): 26.3 mm in height and 21.5 mm in length. Paratype (USNM 405219): 25.4 mm in height and 23.7 mm in length. Paratype (USNM 405218): 27.9 mm in height and 7.2 mm in length.

Discussion.—*Conradostrea greeni* marks the first appearance of the genus in the Chesapeake Group. It differs from *C. sculpturata* in having more and much smaller ribs and in being smaller. *Conradostrea greeni* is known only from the Cobham Bay Member of the Eastover Formation and its close relative, *C. sculpturata*, is known only from the upper Yorktown (upper three members) and the Chowan River Formation in the study area.

Etymology.—*Conradostrea greeni* is named in honor of J. B. Green of Denver, Colorado.

Type information.—Holotype (USNM 405216). Paratypes: USNM 405217, USNM 405218, USNM 405219. Type locality: Right bank of the Rappahannock River, just below the mouth of Whiting Creek, Middlesex County, Va.

Figured specimen.—Holotype (USNM 405216).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Subclass HETEROCONCHIA Cox, 1960
Order VENEROIDA H. Adams and A. Adams, 1856
Superfamily LUCINOIDEA Fleming, 1828
Family LUCINIDAE Fleming, 1828
Subfamily LUCININAE Fleming, 1828
Genus *Stewartia* Olsson and Harbison, 1953

Stewartia anodonta (Say, 1824)
Plate 8, figure 6; Plate 19, figure 1;
Plate 21, figure 9; Plate 24, figure 10

Lucina anodonta Say, 1824, p. 146–147, Pl. X, fig. 9.
Phacoides (*Pseudomiltha*) *anodonta* (Say). Dall, 1903, p. 1378.
Phacoides (*Pseudomiltha*) *anodonta* (Say). Glenn, 1904, p. 337, Pl. XC, figs. 3, 4.
Phacoides (*Pseudomiltha*) *paranodonta* Gardner, 1926c, p. 113, Pl. 20, figs. 3–5.
Phacoides (*Pseudomiltha*) *nocariensis* Kellum, 1926, p. 37, Pl. IX, figs. 4–5.
Saxolucina (*Megaxinus*) *anodonta* (Say). Schoonover, 1941, p. 217–218, Pl. 10, fig. 5.
Phacoides anodonta (Say). Richards and Harbison, 1942, p. 192, Pl. 11, figs. 15, 16.
Phacoides (*Stewartia*) *anodonta* (Say). Olsson and Harbison, 1953, p. 82.
Phacoides (*Stewartia*) *anodonta intermixta* Olsson and Harbison, 1953, p. 82–83, Pl. 12, fig. 2.
Saxolucina (*Megaxinus*) *anodonta* (Say). Vokes, 1957, p. 14, Pl. 11, figs. 4, 5.
Megaxinus (*Stewartia*) *anodonta* (Say). Glibert and van de Poel, 1967, p. 33.
Lucina (*Stewartia*) *anodonta* (Say). Bretsky, 1976, p. 256–257, Pl. 26, figs. 6–8.
Stewartia anodonta (Say). Ward and Powars, 1989, p. 35, Pl. 9, fig. 1; Pl. 10, fig. 6.

Discussion.—*Stewartia anodonta* (Say) makes its first appearance in the Haywood Landing Member of the Belgrade Formation (upper Oligocene and lower Miocene) and is continuously represented in the Miocene and Pliocene beds of the Chesapeake Group. The taxon is believed to have been a temperate to sub-tropical form which became extinct during the global cooling event after the deposition of the Yorktown Formation and before the deposition of the Chowan River Formation. A tropical form, *S. floridana* (Conrad, 1833), is extant and is present in beds along the Atlantic Coastal Plain as low in the section as the James City Formation (lower Pleistocene) in North Carolina. Today *S. floridana* (Conrad, 1833) occurs on the west coast of Florida and in the Gulf of Mexico (Abbott, 1974, p. 462).

Type information.—Type: BM(NH) L13198. Type locality: said to be "Maryland" by Say (1824) but is probably the bluffs along the York River near Yorktown, Va. See the discussion on *Rasia arata* (Say).

Figured specimens.—Plate 8, figure 6: Left valve (USNM 405220) from the Windmill Point beds of the St. Marys Formation, 0.5 miles above Windmill Point, right bank of the St. Marys River, St. Marys County, Md. (locality 12). Plate 19, figure 1: Right valve (USNM 405221) from the Drumcliff Member of the Choptank Formation, Drumcliff on the Patuxent River, St. Marys County, Md. (locality 16). Plate 21, figure 9: Right valve (USNM 405222) from Bed 10 of the Plum Point Marl Member of the Calvert Formation, Camp Roosevelt on the western shore of the Chesapeake Bay, Calvert County, Md. Plate 24, fig. 10: Right valve (USNM 405223) from the Haywood Landing Member of the Belgrade Formation, Silverdale, Onslow County, N.C. (locality 30).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member, in North Carolina (upper Oligocene and lower Miocene). Calvert, Choptank, St. Marys, Eastover, and Yorktown Formations of Maryland and Virginia (lower Miocene through upper Pliocene). Yorktown and Raysor Formations (upper Pliocene) of North Carolina and South Carolina. Reported by Mansfield (1932) from the Choctawhatchee Formation (upper Miocene) of Florida.

Stewartia foremani (Conrad, 1841)
Plate 21, figures 7, 8

Lucina foremani Conrad, 1841, p. 29.
Lucina foremani Conrad. Conrad, 1842*a*, p. 184.
Lucina foremani Conrad. Conrad, 1845, p. 71, Pl. 40, fig. 4.
Phacoides (*Pseudomiltha*) *foremani* (Conrad). Dall, 1903, p. 1378.
Phacoides (*Pseudomiltha*) *foremani* (Conrad). Glenn, 1904, p. 336, Pl. XC, figs. 1, 2.
Saxolucina (*Megaxinus*) *foremani* (Conrad). Schoonover, 1941, p. 217, Pl. 11, fig. 5,
Saxolucina (*Megaxinus*) *foremani* (Conrad). Vokes, 1957, p. 15, Pl. 11, fig. 6.
Megaxinus foremani (Conrad). Glibert and van de Poel, 1967, p. 32.
Lucina (*Stewartia*) *foremani* Conrad. Bretsky, 1976, p. 256.

Discussion.—This taxon, at first glance, appears to represent a distorted *S. anodonta*, a species with which it co-occurs in Bed 10 of the Plum Point Marl Member. Examination of a large number of specimens of the two taxa shows that the two are distinct species

with no gradation of the forms from one to another. *Stewartia foremani* is known only from bed 10 of the Plum Point Marl Member of the Calvert Formation.

Type information.—Type: ANSP 30623. Type locality: "Medial Tertiary deposits of Calvert Cliffs, Maryland" (Conrad, 1841, p. 28). Calvert County, Md.

Figured specimen.—Right valve (USNM 405224) from Camp Roosevelt, on the western shore of the Chesapeake Bay, Calvert County, Md., in Bed 10 of the Plum Point Marl Member.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland.

Subfamily MYRTEINAE Chavan, 1969
Genus *Lucinoma* Dall, 1901

Lucinoma contracta (Say, 1824)
Plate 5, figure 5; Plate 19, figure 2

Lucina contracta Say, 1824, p. 145–146, Pl. X, fig. 8.
Lucina contracta Say. Conrad, 1840, p. 40, Pl. XX, fig. 5.
Lucina contracta Say. Tuomey and Holmes, 1867, p. 54–55, Pl. XVIII, fig. 1.
Lucina contracta Say. Emmons, 1858, p. 291.
Phacoides (Lucinoma) contractus (Say). Dall, 1903, p. 1380.
Phacoides (Lucinoma) contractus (Say). Glenn, 1904, p. 339, Pl. XC, figs. 5, 6.
Lucinoma contractus (Say). Schoonover, 1941, p. 218-219, Pl. 11, fig. 9.
Lucinoma contractus (Say). Vokes, 1957, p. 15, Pl. 11, figs. 7, 8.
Miltha (Lucinoma) contracta (Say). Bretsky, 1976, p. 293.
Lucinoma contracta (Say). Ward, 1984, Pl. 8, fig. 4.
Lucinoma contracta (Say). Ward, 1985*b*, Pl. 8, fig. 4.
Lucinoma contracta (Say). Ward, 1985*c*, Pl. 8, fig. 4.
Lucinoma contracta (Say). Ward, 1987, p. 135, Pl. 8, fig. 4.
Lucinoma contracta (Say). Carter et al., 1988, p. 84, Pl. 8, fig. 64.
Lucinoma contracta (Say). Ward, 1989, p. 85, Pl. 8, fig. 4.
Lucinoma contracta (Say). Ward and Powars, 1989, Pl. 9, fig. 1; Pl. 12, fig. 4.
Lucinoma contracta (Say). Ward, *in* Johnson et al., 1990, Pl. 8, fig. 4.

Discussion.—*Lucinoma contracta* (Say) made its first appearance in Bed 1 of the Fairhaven Member of the Calvert Formation in Maryland and is common in most of the beds of the Calvert, Choptank, St. Marys, Eastover, and Yorktown Formations. The taxon apparently was a temperate to warm-temperate form and appears to have become extinct during the cooling event associated with the Post-Yorktown–Pre-Chowan River lowstand. A surviving species, *L. filosa* (Stimpson), is closely related to *L. contracta* (Say) and occurs from Newfoundland to the Gulf of Mexico but reaches large size only north of North Carolina (Abbott, 1974, p. 461). In the Chesapeake Group, *L. contracta* is most often associated with the basal portions of beds that are related to marine transgressive events. At those horizons the taxon is often abundant.

Type information.—Type: BM(NH) L13196 (both valves). Type locality: Said to be "Maryland" by Say (1824) but is probably the bluffs along the York River near Yorktown, Va. See the discussion on *Rasia arata* (Say).

Figured specimens.—Plate 6, figure 4: Right valve (USNM 380704) from just upriver of the mouth of Sunken Meadow Creek, on the right bank of the James River, Surry County (USGS locality 26041), in the Claremont Manor Member of the Eastover Formation (upper Miocene). Plate 19, figure 2: Right valve (USNM 405225) from Calvert Beach, on the western shore of the Chesapeake Bay, Calvert County, Md., in the Calvert Beach Member of the Calvert Formation (middle Miocene).

Stratigraphic and geographic range.—Calvert, Choptank, St. Marys, Eastover, and Yorktown Formations (lower Miocene through upper Pliocene) of Maryland and Virginia. Yorktown and Raysor Formations (upper Pliocene) in North and South Carolina. Jackson Bluff Formation (upper Pliocene) in Florida. Reported from the Choctawhatchee Formation (upper Miocene) in Florida by Mansfield (1932).

Family UNGULINIDAE H. Adams and A. Adams, 1857
Genus *Timothynus* Harris and Palmer, 1946

Timothynus subvexa (Conrad, 1838)
Plate 19, figure 3

Veneruptis subvexa Conrad, 1833, p. 342.
Sphaerella subvexa (Conrad). Conrad, 1838, p. 18, Pl. X, fig. 2.
Erycina subconvexa d'Orbigny, 1852, vol. 3, p. 115, (no. 2152).
Diplodonta (Sphaerella) subvexa (Conrad). Dall, 1900, p. 1186.
Diplodonta subvexa (Conrad). Glenn, 1904, p. 335–336, Pl. LXXXIX, figs. 9, 10.
Diplodonta (Sphaerella) subvexa (Conrad). Mansfield, 1932, p. 106, Pl. 21, figs. 24, 25.
Diplodonta subvexa (Conrad). Vokes, 1957, p. 15, Pl. 11, figs. 11, 12.
Timothynus subvexa (Conrad). Ward and Powars, 1989, p. 35, Pl. 9, fig. 3.

Discussion.—The type locality of *Timothynus subvexa* (Conrad) is in the upper Yorktown Formation in Virginia, but the species is present in Bed 10 of the Plum Point Marl Member of the Calvert Formation, in the Calvert Beach Member of the Calvert Formation, in the Drumcliff Member of the Choptank Formation, in the Windmill Point beds of the St. Marys Formation, and in the Eastover Formation. The genus *Sphaerella*, which Conrad erected to accommodate the taxon, was preoccupied, hence the establishment of the genus (at first subgenus) of *Timothynus* by Harris and Palmer (1946, p. 86).

Type information.—Type: The type of *T. subvexa* is not listed as being in the Academy of Natural Sciences of Philadelphia collections by Moore (1962) or Richards (1968), and it is not in the Conrad collection as of December 1985. Since it appears lost, I herein designate a topotype specimen (USNM 405226) as the neotype. This specimen is from the "James River near Smithfield," specifically from above Rushmere Wharf, Isle of Wight County, Va., in the Rushmere Member of the Yorktown Formation.

Figured specimen.—Right valve (USNM 405227) from Calvert Beach, Calvert County, Md., from the Calvert Beach Member of the Calvert Formation.

Stratigraphic and geographic range.—Calvert, Choptank, St. Marys, Eastover, and Yorktown Formations (lower Miocene through upper Pliocene) in Maryland and Virginia. Red Bay Formation (upper Miocene) in Florida.

Superfamily CHAMOIDEA Lamarck, 1809
Family CHAMIDAE Lamarck, 1809
Genus *Chama* Linné, 1758

Chama chipolana Dall, 1903
Plate 24, figures 6–9

Chama chipolana Dall, 1903, p. 1398, Pl. 56, figs. 19, 20.
Chama chipolana Dall. Dall, 1915, p. 135, Pl. 25, figs. 9, 11.
Pseudochama chipolana (Dall). Gardner, 1926*b*, p. 94, Pl. XVII, figs. 9–10.

Discussion.—This taxon is known on the Atlantic Coastal Plain only from the Haywood Landing Member of the Belgrade Formation in N.C. It provides a reliable correlation with the tropical assemblages associated with the Tampa Limestone and Chipola Formation of Florida, both early Miocene in age.

Type information.—Holotype: USNM 114725. Type locality: Chipola River, Florida.

Figured specimens.—Plate 24, figures 6, 7: Left valve (USNM 405228) from the Martin Marietta Company, Belgrade Quarry, Belgrade, N.C. (locality 29), in the Haywood Landing Member of the Belgrade Formation. Plate 24, figures 8, 9: Right valve (USNM 405229) from the same locality.

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) of North Carolina; Tampa Limestone (upper Oligocene and lower Miocene) and Chipola Formation (middle Miocene) of Florida.

Superfamily CARDITOIDEA Fleming, 1820
Family CARDITIDAE Fleming, 1828
Subfamily CARDITAMERINAE Chavan, 1969
Genus *Cyclocardia* Conrad, 1867

Cyclocardia trentensis, new species
Plate 25, figure 2

Venericardia (*Cyclocardia*) *granulata* Say. Kellum, 1926, p. 37. [Not of Say, 1824].
Venericardia granulata Say. Richards, 1943, p. 520, Pl. 84, figs. 18, 19. [Not of Say, 1824].

Diagnosis.—Shell sub-circular, prosocline, with 18–25 low, smooth, radiating ribs.

Description.—Shell equivalved, very prosocline with prominent beak in anterior one-quarter of length. Ribs radiating from umbones, varying in number from 18 to 25. Ribs low and smooth with interspaces half as wide. Ribs widest and most prominent in mid-region of disk, becoming smaller and more crowded anteriorly and posteriorly. Some concentric rings, but most inconspicuous.

Umbones low, very small, narrow lunule, escutcheon not defined. Hinge plate and teeth large for size of shell. Left valve with long, thin posterior cardinal tooth running parallel to almost straight ligamental nymphs. A large socket present to accept the V-shaped cardinal tooth of the right valve. Anterior cardinal small and at nearly right angles to the posterior cardinal in the left valve. Anterior adductor muscle scar well-defined and lunate. Posterior adductor muscle scar sub-circular and less well-defined. Anterior pedal retractor scar small, deeply impressed and several millimeters above the anterior adductor scar. Posterior pedal retractor scar small, less well-defined and just above the posterior adductor scar. Pallial line entire, wide, well-defined, and remote

from shell margins. Margin strongly crenulated to agree with exterior radial ribs.

Measurements (in millimeters).—

Measured specimen	valve	height	length	width
Holotype (USNM 405230)	LV	14.9	16.1	3.2
Paratype (USNM 405231)	LV	18.0	19.2	5.0
Paratype (USNM 405232)	RV	12.8	14.4	4.2
Paratype (USNM 405233)	RV	11.9	13.2	3.6
Paratype (USNM 405234)	LV	9.0	9.3	2.7

Discussion.—This species approaches and is probably closely related to *Cyclocardia castrana* (Glenn, 1904), but is easily separated from that taxon by its larger hinge and teeth and its marked prosocline outline. Kellum (1926) reported *Venericardia* (*Cyclocardia*) *granulata* Say from the Trent Formation (the stratigraphic unit that the specimens came from is now included in the Haywood Landing Member of the Belgrade Formation) and indicated that he considered it identical with the Maryland species but did not figure any specimens. Richards (1943) figured two specimens from the Silverdale area and also referred them to *Venericardia granulata* Say. Ward and Blackwelder (1975) showed that the specimens collected by John Finch and described by Thomas Say (1824) were obtained from the Yorktown area in Virginia and not "Maryland" as reported. The type of *Cyclocardia granulata* (Say, 1824) was collected by Finch in what is now known as the Yorktown Formation. *Cyclocardia granulata* (Say) first appears in the lower Yorktown Formation (lower Pliocene), but ranges as high as the James City Formation (lower Pleistocene). *Cyclocardia castrana* (Glenn) and *Cyclocardia trentensis* n. sp. are clearly related to *Cyclocardia granulata* (Say) but are distinct and appear to be early members of a lineage that is remarkably well-represented in western Atlantic Coastal Plain deposits and is still extant.

The specimens from Belgrade are usually worn, but a few preserve the exterior character of the species. The prosocline outline is easily recognized, however, in the most worn specimens.

Type information.—Holotype: USNM 405230. Type locality: Martin Marietta Company, Belgrade Quarry, Onslow County, N.C. in the Haywood Landing Member of the Belgrade Formation.

Figured specimen.—Holotype, a left valve (USNM 405230).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in N.C.

Subfamily VENERICARDIINAE Chavan, 1969
Genus *Glyptoactis* Stewart, 1930

Glyptoactis nodifera (Kellum, 1926)
Plate 25, figure 1

Venericardia nodifera Kellum, 1926, p. 36–77, Pl. IX, figs. 1–3.
Venericardia nodifera Kellum. Mansfield, 1937, p. 236.
Venericardia nodifera Kellum. Richards, 1943, p. 520.
Venericardia nodifera Kellum. Richards, 1950, p. 76, fig. 66d, e.
Venericardia (*Glyptoactis*) *nodifera* Kellum. Heaslip, 1968, p. 111–112, Pl. 27, figs. 5, 6.

Discussion.—This is the stratigraphically highest as well as the northernmost known occurrence of an alticostate venericardiid on the Atlantic Coastal Plain. The taxon is common in the Haywood Landing Member of the Belgrade Formation and its stratigraphic equivalent in South Carolina, the Edisto Formation. It is not known from the Old Church Formation of Virginia.

Type information.—Holotype: USNM 353227. Type locality: 0.8 km south of Silverdale, on the left side of Webbs Creek, in drainage pits and soil banks, Onslow County, N.C. (USGS locality 10655). Said to be from the Trent Formation by Kellum (1926). Stratigraphic revision by Ward and others (1978) now places these beds in the Haywood Landing Member of the Belgrade Formation.

Figured specimen.—Right valve (USNM 405235) from the Silverdale Marl Company Quarry at Silverdale, Onslow County, N.C. (locality 30, USGS locality 26571).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (lower Miocene) in North Carolina; Edisto Formation (lower Miocene) in South Carolina.

Superfamily CRASSATELLOIDEA Férussac, 1822
Family ASTARTIDAE d'Orbigny, 1844
Subfamily ASTARTINAE d'Orbigny, 1844
Genus *Astarte* J. Sowerby, 1816

Astarte rappahannockensis (Gardner, 1944)
Plate 3, figure 3

Astarte (*Ashtarotha*) *rappahannockensis* Gardner, 1943 [1944], p. 56–57, Pl. 12, figs. 19–20.
Astarte rappahannockensis (Gardner). Ward and Blackwelder, 1980, Pl. 3, fig. 2.
Astarte rappahannockensis (Gardner). Ward, 1984, Pl. 11, fig. 2.
Astarte rappahannockensis (Gardner). Ward, 1985*b*, Pl. 11, fig. 2.

Astarte rappahannockensis (Gardner). Ward, 1985c, Pl. 11, fig. 2.
Astarte rappahannockensis (Gardner). Ward, 1987, p. 138, Pl. 11, fig. 2.
Astarte rappahannockensis (Gardner). Ward, 1989, p. 88, Pl. 11, fig. 2.
Astarte rappahannockensis (Gardner). Ward and Powars, 1989, p. 41, Pl. 15, fig. 2.
Astarte rappahannockensis (Gardner). Ward, *in* Johnson et al., 1990, Pl. 11, fig. 2.

Discussion.— *Astarte rappahannockensis* is common in the *Mercenaria-Isognomon* (*Hippochaeta*)*-Glycymeris* biofacies of the Cobham Bay Member of the Eastover Formation. It is present but less common in the inner bay facies of the Cobham Bay Member, which is dominated by *Spisula rappahannockensis*. The taxon is recognized by its undulant beak area and its otherwise smooth disk.

Type information.—Holotype: USNM 325527. Type locality: "Rappahannock River bluffs near Urbanna, Va." (Gardner, 1943 [1944], p. 57).

Figured specimen.—A left valve (USNM 258365) from 1.3 km below Sunken Meadow Creek on the James River, Surry County, Va. (locality 7).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Astarte cobhamensis new species
Plate 3, figure 1

Diagnosis.—Shell small, trigonal, low, with numerous, very fine, equally spaced, concentric undulations.

Description.—Shell somewhat small for the genus, thin, with slightly inflated, low umbones. Posterior slope steep, becoming rounded. Anterior slope slightly convex near the beak, otherwise nearly straight. Ventral margin broadly rounded. External surface sculptured with many very fine, equally spaced, concentral undulations. Ligament opisthodetic, dentition worn in the holotype (a right valve) but consists of a small anterior cardinal and a strong middle cardinal. Lunule elongate-cordate, escutcheon lanceolate, both weakly expressed. Anterior aductor scar large and deeply impressed, the posterior adductor scar equally large but only slightly impressed. Anterior pedal retractor scar distinct and deep. Pallial line entire and remote from the ventral margin of shell. Inner margin of holotype non-crenulate. Dimensions of the holotype (USNM 405236): length, 14.7 mm, height, 15.0 mm, convexity, 3.9 mm.

Discussion.—*Astarte cobhamensis* is similar to *A. exaltata* but has more numerous and finer concentric undulations. The species' trigonal shape and finely scuptured disk is similar to *A. concentrica*, a Pliocene form, but that species is much larger and more elongate. *Astarte cobhamensis* is known only from the Cobham Bay Member of the Eastover Formation.

Type information.—Holotype: USNM 405236. Type locality: 0.8 km below Cobham Wharf, right bank of the James River, Surry County, Va. (locality 3), in the Cobham Bay Member of the Eastover Formation.

Figured specimen.—Holotype (USNM 405236).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Astarte perplana Conrad, 1840
Plate 7, figure 5

Astarte perplana Conrad, 1840, p. 43, Pl. XXI, fig. 3.
Astarte (*Ashtarotha*) *perplana* Conrad. Dall, 1903, p. 1493.
Astarte perplana Conrad. Glenn, 1904, p. 356–357, Pl. XCIV, figs. 10, 11.
Astarte perplana Conrad. Vokes, 1957, p. 13, Pl. 9, figs. 10, 11.
Not—
Astarte perplana Conrad. Richards and Harbison, 1942, p. 189, Pl. 10, figs. 7, 8.
Astarte (*Ashtarotha*) *perplana* Conrad. Olsson and Harbison, 1953, p. 69, Pl. 15, fig. 9.

Discussion.—*Astarte perplana* is distinguished by its low, compressed shell and its slightly elongate outline. Low, irregularly spaced, concentric undulations are present on the beak but become flattened and obscure distally. The taxon is common in the Windmill Point beds of the St. Marys Formation in Maryland and Virginia. It is present on the St. Marys River above Windmill Point (locality 12, USGS locality 26554) and below Chancellors Point (locality 13, USGS locality 26555). In Virginia, it is present at Essex Mill, Essex County (locality 14, USGS locality 26091), and on the Mattaponi River at White Oak Landing (locality 8, USGS locality 26046). This species is probably not allied with the subgenus *Ashtarotha* Dall as assigned by Dall (1903).

Type information.—Lectotype: ANSP 18849. Two left valves and two right valves are in the type lot (ANSP 18849). None of the specimens agree with Conrad's (1840) figure although all of the specimens clearly are from the Windmill Point beds of the St. Marys and probably came from the St. Marys River,

Md. One right valve is very similar to the figured specimen but is somewhat smaller. This may be a product of artistic license as many of Conrad's figures are poorly rendered. I herein designate that specimen the lectotype. Measurements of the lectotype: length, 27.4 mm; height, 28.5 mm; convexity, 5.5 mm. Type locality: "St. Mary's River, Maryland" (Conrad, 1840, p. 43). Specimens of *A. perplana* are known only from the Windmill Point beds of the St. Marys Formation on the St. Marys River.

Figured specimen.—A topotype specimen, a left valve (USNM 405237) from below Chancellor Point, St. Marys County, Md. (locality 13).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene), in Maryland and Virginia.

Astarte obruta Conrad, 1834
Plate 15, figure 3

Astarte obruta Conrad, 1834, p. 150–151
Astarte obruta Conrad. Conrad, 1840, p. 43, Pl. XXI, fig. 2.
Astarte (Ashtarotha) obruta Conrad. Dall, 1903, p. 1490–1491.
Astarte obruta Conrad. Glenn, 1904, p. 354–355, Pl. XCIV, figs. 5, 6.
Astarte obruta Conrad. Schoonover, 1941, p. 46, Pl. 8, fig. 5.
Astarte obruta Conrad. Vokes, 1957, p. 13, Pl. 9, fig. 8.
Astarte obruta Conrad. Mongin, 1959, p. 319.
Astarte obruta Conrad. Blackwelder and Ward, 1976, p. 42, 43, Pl. 1, fig. 5.
Not—
Astarte obruta Conrad. Richards, 1950, p. 78, figs. 69 f, g.

Discussion.—*Astarte obruta* is distinguished by its trigonal outline, inflated umbo, and the few, very regular concentric undulations on the beak. The rest of the disk is smooth with only a few, irregularly spaced, very low undulations. The species is abundant in the Boston Cliffs Member of the Choptank Formation at Boston Cliffs on the Choptank River, Talbot County, Md. *Astarte obruta* is not here included in the subgenus *Ashtarotha* as suggested by Dall (1903).

Type information.—Lectotype: Type lot ANSP 30594. The type lot 30594 contains eight specimens. Five of the specimens are various species probably accidentally introduced by later workers and are not found in Maryland in the Choptank Formation nor at the type locality. These are *A. undulata* Say, *A. perplana* Conrad, and *A. symmetrica*. Three specimens in the lot belong to *A. obruta*. One specimen, a right valve, is herein selected as lectotype. It agrees well with Conrad's (1840, Pl. XXI, fig. 2) figure. Measurements of the lectotype: length, 28.3 mm; height, 24.0 mm; convexity, 6.7 mm. Type locality: "Choptank River, Md." (Conrad, 1834, p. 150), "Choptank River, near Easton, Md." (Conrad, 1840, p. 43). Conrad was referring to Boston Cliffs, just downriver from the Route 331 bridge, on the right bank of the Choptank River, Talbot County, Md.

Figured specimen.—Topotype specimen, a left valve (USNM 405238) from below Dover Bridge (Route 331), on the right bank of the Choptank River, Talbot County, Md.

Stratigraphic and geographic range.—Choptank Formation, Boston Cliffs Member, Bed 19 (upper middle Miocene), in Maryland and Virginia.

Astarte thisphila Glenn, 1904
Plate 19, figure 4

Astarte thisphila Glenn, 1904, p. 355–356, Pl. XCIV, figs. 7–9.
Astarte thisphila Glenn. Schoonover, 1941, p. 210, Pl. 8, figs. 1, 4.
Astarte thisphila Glenn. Vokes, 1957, p. 13, Pl. 9, figs. 6, 7, 9.
Astarte thisphila Glenn. Mongin, 1959, p. 318–319.
Astarte (Ashtarotha) thisphila Glenn. Glibert and van de Poel, 1970, p. 80.
Astarte thisphila Glenn. Blackwelder and Ward, 1976, p. 42, Pl. 1, fig. 4.
Astarte thisphila Glenn. Ward and Powars, 1989, p. 35, Pl. 9, fig. 4.

Discussion.—*Astarte thisphila* is well-characterized by the numerous, strongly developed concentric undulations, which increase in size over the whole disk from the beak to the ventral margins. This taxon appears to respond to its substrate conditions, in that specimens from the clean fine sands of the Drumcliff Member of the Choptank Formation are thick, with well-developed undulations, while specimens on the margins of the basin in more muddy sediments are thinner, wider, less-inflated, and have less-pronounced undulations. The two forms do grade from one to another and are considered to be the same species.

Type information.—Lectotype: USNM 360312. Only two specimens remain in the Glenn type collection. The specimen that he figured (Glenn, 1904, Pl. XCIV, fig. 7) is herein selected to be the lectotype. Type locality: Not designated but all of the specimens figured by Glenn (1904) came from Jones Wharf, on the right bank of the Patuxent River, St. Marys County, Md. (same as locality 16 of this report).

Figured specimen.—Topotype specimen, a left valve

(USNM 405239) from Jones Wharf, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Calvert Formation, Calvert Beach Member (lower middle Miocene) of Maryland and Virginia. Choptank Formation, Drumcliff and St. Leonard Members (middle middle Miocene) in Maryland. Abundant only in the Drumcliff Member.

Astarte cuneiformis Conrad, 1840
Plate 22, figure 5

Astarte cuneiformis Conrad, 1840, p. 42, Pl. XX, fig. 9.
Astarte cuneiformis Conrad. Whitfield, 1894, p. 52–53, Pl. VIII, figs. 8–10.
Astarte (Ashtarotha) cuneiformis Conrad. Dall, 1903, p. 1494.
Astarte cuneiformis Conrad. Glenn, 1904, p. 353, Pl. XCIII, figs. 4–6.
Astarte cuneiformis Conrad. Schoonover, 1941, p. 202–205, Pl. 6, figs. 1, 2, 5, 6; Pl. 7, figs. 5, 6.
Astarte cuneiformis Conrad. Richards and Harbison, 1942, p. 189, Pl. 10, figs. 9, 10.
Astarte cuneiformis Conrad. Vokes, 1957, p. 13, Pl. 9, figs. 1–3.
Astarte cuneiformis Conrad. Ward, 1984, Pl. 7, fig. 6.
Astarte cuneiformis Conrad. Ward, 1985*b*, Pl. 7, fig. 6.
Astarte cuneiformis Conrad. Ward, 1985*c*, Pl. 7, fig. 6.
Astarte cuneiformis Conrad. Ward, 1987, p. 134, Pl. 7, fig. 6.
Astarte cuneiformis Conrad. Ward, 1989, p. 84, Pl. 7, fig. 6.
Astarte cuneiformis Conrad. Ward and Powars, 1989, p. 33, Pl. 7, fig. 6.
Astarte cuneiformis Conrad. Ward, *in* Johnson, 1990, Pl. 7, fig. 6.

Discussion.—This species is variable in outline and sculpture, and a number of subspecies have been named by Glenn (1904) and Dall (1903). It is distinguished by its thin, compressed valves, which are posteriorly elongate. Exterior sculpture varies from smooth to finely undulate. The taxon does not belong in the subgenus *Ashtarotha* as suggested by Dall (1903). *Astarte cuneiformis* is abundant in Bed 10 of the Plum Point Marl Member of the Calvert Formation, and external molds in Bed 2 of the Fairhaven Member of the same formation also appear to be that species.

Type information.—Neotype: USNM 360301. Conrad's type material for the species appears to be lost. It was not listed by Richards (1968) and was not present in the collections at the Academy of Natural Sciences of Philadelphia as of December 1985. Glenn's (1904) figured specimen, Pl. XCIII, fig. 4, is herein designated the neotype (USNM 360301).

Figured specimen.—Left valve (USNM 405240) from Camp Roosevelt, on the western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland. Possibly from the Fairhaven Member, Bed 2 (lower Miocene), Maryland. Kirkwood Formation (lower Miocene) in New Jersey.

Astarte onslowensis Kellum, 1926
Plate 24, figure 4

Astarte onslowensis Kellum, 1926, p. 36, Pl. VIII, figs. 8–10.
Astarte onslowensis Kellum. Richards, 1943, p. 520.
Astarte onslowensis Kellum. Carter et al., 1988, p. 82, Pl. 7, fig. 53.

Discussion.—This small species seems to be one of the earliest of the warm-temperate to sub-tropical forms that thrived in the marine embayments of the Atlantic Coastal Plain during the Miocene and Pliocene. It is known only from the Belgrade Formation, Haywood Landing Member, in North Carolina. Its short trigonal outline and exterior concentric undulations separate this taxon from *A. claytonrayi*, new species, with which it co-occurs.

Type information.—Holotype: USNM 353244. Type locality: "Silverdale, Onslow County, N.C." (Kellum, 1926, p. 36). USGS locality 10655, "half a mile [0.8 km] southeast of Silverdale, on farm of John Gillette, on left side of Webbs Creek." (Kellum, 1926, p. 13).

Figured specimen.—Holotype (USNM 353244), a right valve from Silverdale, Onslow County, N.C. (USGS locality 10655).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Astarte claytonrayi, new species
Plate 24, figures 3, 5

Diagnosis.—Shell average size for genus, very smooth exteriorly with a pronounced prosocline outline.

Description.—Very small, regular, evenly spaced, narrow undulations originating from the earliest stages of shell development and persisting over one-half of the disk. Undulations grading to a lower amplitude until reduced to faintly impressed concentric lines, giving the ventral portion of the shell a smooth, polished appearance.

Beak prominent and placed well forward. Lunule narrow, lanceolate, and deeply concave. Escutcheon slightly longer and narrower than the lunule and deeply excavated. Posterior dorsal slope elongate and gradual, anterior dorsal slope short and abrupt. Ventral margin broadly rounded.

Hinge plate strong, moderately arched, with a deeply incised ligamental suture and smooth ligamental nymph. Left valve with long, shallow socket to house posterior lateral tooth of right valve. Left valve with a posterior lateral tooth crenulated on the anterior margin and an anterior cardinal with crenulations on anterior and posterior margins. A socket between the anterior and posterior cardinals houses the large crenulated cardinal tooth of the right valve. A very small, shallow socket located just anterior to the anterior cardinal and posterior to the lunule in the left valve houses an equally diminutive anterior cardinal on the right valve. Anterior-dorsal margin of left valve, just below lunule, produced to form long projecting anterior lateral tooth. Right valve with corresponding socket.

Anterior adductor muscle scar lunate, posterior adductor scar subcircular, both well impressed. Anterior pedal retractor scar very deep, small, and located several millimeters above the anterior adductor. Posterior pedal retractor scar less well defined, small, and located adjacent to and dorsal to posterior adductor scar. Three smaller, very deeply impressed scars located below and under the hinge plate probably represent the pedal elevator muscle scars.

The pallial line is simple, entire, clearly defined, and remote from the ventral margin. Ventral margin not crenulated in any of the studied specimens.

Measurements (in millimeters).—

Measured specimen	valve	height	length	width
Holotype (USNM 405241)	LV	15.9	16.1	4.3
Paratype (USNM 405242)	RV	14.0	16.4	3.8
Paratype (USNM 405243)	RV	17.5	20.1	4.3
Paratype (USNM 405244)	LV	19.4	22.0	5.3
Paratype (USNM 405245)	LV	16.0	17.5	4.2
Paratype (USNM 405246)	LV	14.3	15.2	3.6

Discussion.—The smooth appearance and prosocline outline of this *Astarte* serve to distinguish it from other species. No known forms of *Astarte* in the lower Miocene of Maryland or Florida approach the outline of this taxon. At Belgrade the species is fairly common, but usually worn. Few specimens exhibit the delicate undulations on the umbo. Even when worn, the characteristic outline of the taxon makes its identification relatively simple.

Etymology.—*Astarte claytonrayi* is named in honor of Dr. Clayton E. Ray of the National Museum of Natural History, a longtime advisor, cohort, and friend.

Type information.—Holotype: USNM 405241. Type locality: Top, sandy shell bed above the hard, sandy biosparrudite at the Martin Marietta Company Quarry at Belgrade just east of the intersection of Route 17 and Route 1434, Onslow Co., N.C. (locality 29).

Figured specimen.—Holotype (USNM 405241).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Family CRASSATELLIDAE Férussac, 1822
Subfamily CRASSATELLINAE Férussac, 1822
Genus *Marvacrassatella* Ward and Blackwelder, 1987

Marvacrassatella urbannaensis (Mansfield, 1929)
Plate 3, figure 2

Crassatellites (*Crassatellites*) *meridionalis urbannaensis* Mansfield, 1928*a* [1929], p. 9, Pl. 4, figs. 3, 4. [pub. in 1929, see references].

Marvacrassatella urbannaensis (Mansfield). Ward and Blackwelder, 1987, p. 151

Discussion.—Mansfield (1928*a* [1929]) pointed out that *Marvacrassatella urbannaensis* differs from M. *surryensis* "in having a more inequilateral shell and a shorter radial continuation of nepionic undulations." *Marvacrassatella urbannaensis* is present, but never abundant, in the *Spisula rappahannockensis* biofacies of the northern Cobham Bay basin, but it is common in the *Isognomon* beds. The type locality is presently slumped and inaccessible, but the species is common in exposures along Urbanna Creek, Middlesex County, and at Cobham Wharf, Surry County, Va.

Type information.—Holotype: USNM 370831. Type locality: "St. Marys Formation, Zone 2, U.S.G.S. station 3915, Urbanna, Va...." (Mansfield, 1928*a* [1929], p. 9).

Figured specimen.—Right valve of a specimen (USNM 405247) from Urbanna Creek, upstream from Urbanna, Middlesex County, Va.

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) of Virginia.

Marvacrassatella surryensis (Mansfield, 1929)
Plate 6, figure 2

Crassatellites (*Crassatellites*) *meridionalis surryensis* Mansfield, 1928*a* [1929], p. 8–9, Pl. 5, fig. 3, 6. [pub. in 1929, see references].

"*Crassatella*" *surryensis* (Mansfield). Ward, 1984, Pl. 8, fig. 5.

"*Crassatella*" *surryensis* (Mansfield). Ward, 1985*b*, Pl. 8, fig. 5.

"*Crassatella*" *surryensis* (Mansfield). Ward, 1985*c*, Pl. 8, fig. 5.

"*Crassatella*" *surryensis* (Mansfield). Ward, 1987, p. 135, Pl. 8, fig. 5.

Marvacrassatella surryensis (Mansfield). Ward and Blackwelder, 1987, p. 151.

Marvacrassatella surryensis (Mansfield). Ward, 1989, p. 85, Pl. 8, fig. 5.

Marvacrassatella surryensis (Mansfield). Ward and Powars, 1989, Pl. 12, fig. 5.

"*Crassatella*" *surryensis* (Manfield). Ward, *in* Johnson et al., 1990, Pl. 8, fig. 5.

Discussion.—Mansfield (1928*a* [1929], p. 8–9) pointed out that *Crassatellites surryensis* was more elongate than *C. urbannaensis* and its concentric undulations in the beak area were more extensive. Otherwise the two taxa, and a similar form in the Windmill Point beds of the St. Marys, are closely related. *Marvacrassatella surryensis* is common but never abundant in the Claremont Manor Member of the Eastover Formation and is well-preserved in that unit around Claremont and Cobham Wharf, Surry County, Va.

Type information.—Holotype: USNM 370832. Type locality: "USGS station 1/244, right bank of James River 1F miles below Claremont Wharf, Va., from lowest bed" (Mansfield, 1928*a* [1929], p. 9).

Figured specimen.—Left valve (USNM 380705) from just above the mouth of Sunken Meadow Creek on the right bank of the James River, Surry Co., Va. (USGS locality 26041).

Stratigraphic and geographic range.—Eastover Formation, Claremont Manor Member (upper Miocene) in Virginia.

Marvacrassatella marylandica (Conrad, 1832)
Plate 14, figures 7, 8

Crassatella marylandica Conrad, 1832, p. 22, Pl. 8, fig. 1.

Crassatella marylandica Conrad. Conrad, 1838, p. 21, Pl. XII, fig. 1.

Crassatellites (*Scambula*) *marylandicus* (Conrad). Dall, 1903, p. 1473.

Crassatellites marylandicus (Conrad). Glenn, 1904, p. 347–348, Pl. XCIII, figs. 1–3.

Eucrassatella marylandica (Conrad). Schoonover, 1941, p. 215, Pl. 8, figs. 2, 3, 6.

Eucrassatella marylandica (Conrad). Vokes, 1957, p. 14, Pl. 10, figs. 6, 7.

Marvacrassatella marylandica (Conrad). Blackwelder and Ward, 1976, p. 42–43, Pl. 1, fig. 7. [name and figure only].

Discussion.—*Marvacrassatella marylandica* is often confused with *M. turgidula*, especially in the poorly preserved assemblages of the Choptank Formation. *Marvacrassatella marylandica* is more trigonal in form than *M. turgidula* due to its prominent, sharp beak and is more produced posteriorly. In addition, the concentric undulations on the beak and umbo are finer and more closely spaced than on *M. turgidula*.

Type information.—Lectotype: ANSP 30534. Conrad's type material consists of two complete specimens (double valves). The larger of the two is the specimen figured by Conrad (1832, Pl. 8, fig. 1) and is herein designated the lectotype. Type locality: "Choptank River, near Easton, Md." (Conrad, 1832, p. 22). Conrad was referring to Boston Cliffs, just downriver from the Route 331 bridge, on the right bank of the Choptank River, Talbot County, Md.

Figured specimen.—Left valve (USNM 405248) from below Flag Pond, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 17).

Stratigraphic and geographic range.—Choptank Formation, Boston Cliffs Member, Bed 19 (upper middle Miocene), Maryland and Virginia.

Marvacrassatella turgidula (Conrad, 1843)
Plate 17, figures 1, 2

Crassatella turgidula Conrad, 1843*a*, p. 307.

Crassatella turgidula Conrad. Conrad, 1845, p. 69–70, Pl. 39, fig. 7.

Crassatellites turgidulus (Conrad). Glenn, 1904, p. 348–349, Pl. XCII, figs. 4, 5.

Eucrassatella turgidula (Conrad). Schoonover, 1941, p. 214–215, Pl. 6, fig. 7; Pl. 7, figs. 8, 9.

Eucrassatella turgidula (Conrad). Vokes, 1957, p. 14, Pl. 10, fig. 5.

Marvacrassatella turgidula (Conrad). Blackwelder and Ward, 1976, p. 42–43, Pl. 1, fig. 6. [name and figure only].

Discussion.—Conrad (1843*a*, p. 307) commented accurately on the differences between *M. turgidula* and *M. marylandica*: "Allied to *C. marylandica*, but has less prominent, more flattened umbones, which are widely and profoundly undulated. It is, also, more ventricose, and has a more regularly arched basal margin. Young shells of the two species are widely unlike each other." *Marvacrassatella turgidula* is com-

mon in the Calvert Beach Member of the Calvert Formation, abundant in the Drumcliff Member of the Choptank Formation, and rare in the St. Leonard Member of the Choptank. Dall (1903, p. 1472) recognized the similarity of his species *Crassatellites (Scambula) densus* to M. *turgidula*. Specimens of M. *densus* (Dall) from the middle Miocene of Florida appear to be smaller, possibly slightly stunted forms of M. *turgidula* and may represent the southern phenotype extremity of the taxon.

Type information.—Lectotype: ANSP, no number. Conrad's type material at the Academy of Natural Sciences of Philadelphia consists of a large, complete (double-valved) specimen and one small worn individual, which is a specimen of M. *melinus*. The large double valve is clearly the originally figured specimen (Conrad, 1845, Pl. 39, fig. 7) and is here designated the lectotype. The small valve of M. *melinus* may be part of the missing type material of that taxon. Type locality: "Calvert Co., Md." (Conrad, 1843*a*, p. 307).

Figured specimen.—Right valve (USNM 405249) from Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (locality 16).

Stratigraphic and geographic range.—Calvert Formation, Calvert Beach Member, Beds 14–15 (lower middle Miocene) in Maryland and Virginia. Choptank Formation, Drumcliff Member and St. Leonard Member (middle middle Miocene) in Maryland and Virginia.

Marvacrassatella melina (Conrad, 1832)
Plate 22, figure 8

Crassatella melina Conrad, 1832, p. 23–24, Pl. 9, fig. 2.
Crassatella melina Conrad. Conrad, 1838, p. 22, Pl. XII, fig. 2.
Crassatella melina Conrad. Whitfield, 1894, p. 60–61, Pl. VIII, figs. 11–13.
Crassatellites melinus (Conrad). Glenn, 1904, p. 346–347, Pl. XCII, figs. 1, 2.
Crassatella melina Conrad. Richards, 1935, p. 208, fig. 1.
Eucrassatella melina (Conrad). Schoonover, 1941, p. 213–214, Pl. 6, figs. 3, 4.
Eucrassatella melina (Conrad). Richards and Harbison, 1942, p. 190, Pl. 10, figs. 14, 15.
Eucrassatella melina (Conrad). Vokes, 1957, p. 14, Pl. 10, fig. 1.
Crassatella melinus Conrad. Ward, 1984, p. 58, Pl. 7, fig. 8.
Crassatella melinus Conrad. Ward, 1985*b*, p. 58, Pl. 7, fig. 8.
Crassatella melinus Conrad. Ward, 1985*c*, Pl. 7, fig. 8.
Crassatella melinus Conrad. Ward, 1987, p. 134, Pl. 7, fig. 8.
Crassatella melinus Conrad. Ward and Powars, 1989, p. 33, Pl. 7, fig. 8.
Marvacrassatella melinus (Conrad). Ward, 1989, p. 84, Pl. 7, fig. 8.
Marvacrassatella melinus (Conrad). Ward, *in* Johnson et al., 1990, Pl. 7, fig. 8.

Discussion.—Valves of *Marvacrassatella melina* are generally thinner, flatter, and smaller than those of M. *marylandica* and M. *turgidula*. The species occurs commonly as whole individuals (double-valved) and is common to abundant in Bed 10 of the Plum Point Marl Member of the Calvert Formation.

Type information.—*Marvacrassatella melina* was not listed by Richards (1968) as being in the Conrad type material at the Academy of Natural Sciences of Philadelphia. No tray for the taxon was present, as of December 1985, in the Conrad collection. A small, broken left valve of M. *melina* was present in the type material of M. *turgidula*. This valve was compared to the original figure (Conrad, 1832, Pl. 9, fig. 2), and it is very similar in outline but is slightly larger. In addition, it has a coating of matrix cemented to the anterior portion of the interior. This is not depicted in the figure but may have been deleted by the artist. The original types came from Stow Creek, Cumberland County, N.J. This specimen may have come from that locality, as I have not seen matrix of this type in the Calvert Formation of Maryland. I herein designate the single specimen of M. *melina* in the Conrad collection in the Academy of Natural Sciences of Philadelphia as lectotype. The specimen is unnumbered. Type locality: Stow Creek, Cumberland County, N.J. Length of the lectotype, 68.4 mm; length of Conrad's (1832, Pl. 9, fig. 2) figured specimen, 62.0 mm.

Figured specimen.—Left valve (USNM 380700) from Camp Roosevelt, western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Kirkwood Formation, New Jersey; Fairhaven Member (Bed 2) and Plum Point Marl Member (Bed 10 and Bed 12) of the Calvert Formation in Maryland and Virginia; Pungo River Formation in North Carolina (all lower and middle Miocene).

Superfamily CARDIOIDEA Lamarck, 1809
Family CARDIIDAE Lamarck, 1809

GENUS *Chesacardium*, new genus

Diagnosis.—Shell large, inflated, subovate, with approximately 38 thin, high, smooth ribs, and with

only a weak modification of the hinge plate that does not attach to the beak.

Description.—Valves large, very deep, evenly inflated, relatively thin, with tumid umbones and small beak. Exterior ornamentation consists of numerous (38 in the genotype), fine, strong, high, smooth ribs, which are reflected by the fluting on the ventral margins. Ribs are crossed by fine concentric lamellae, producing some very fine nodes anteriorly. Lamellae more noticeable between the ribs in interarea. Posterior shoulder weakly angular with flattened, slightly impressed ribs. High umbonal area worn in adults where beaks touch when open. Interior of valve capacious, nearly equilateral, with beaks weakly prosogyrate. Slightly developed lunule, deeply impressed ligamental groove. Two, moderately large, sharply projecting cardinal teeth with an intervening deep socket in the right valve, two corresponding deep sockets, and one projecting cardinal tooth in the left valve. Hinge plate with shallow, lateral, socket-like indentation behind the cardinal teeth and a slightly projecting lateral extension anterior of the cardinal teeth. Anterior and posterior lateral teeth distant from the beak, just behind the anterior and posterior adductor muscle acars, massive, with a deep socket above and a sharp V-shaped tooth below. Lateral teeth in left valve smaller. Interior of valve smooth except for the anterior and ventral margins where the external ribbing is evident and gives the margin a fluted appearance. Anterior adductor scar semi-lunate, distinct, extending up under the projecting anterior lateral tooth. Posterior adductor scar subovate. Pallial line indiscernible.

Discussion.—*Chesacardium* is distinguished by its large, thin, deep, finely ribbed valves. Species herein assigned to this new taxon have been included in various genera such as *Cardium*, *Cerastoderma*, and *Dinocardium*. *Cardium* (type, *C. costatum* Linné) has sharply keeled or spinose ribs and is a living taxon from West Africa. *Cerastoderma*, type–*C. edule* (Linne), has stronger ribs, sculptured with cross-threads and a massive hinge plate. *Dinocardium* is closely allied, but it is more tumid in the umbonal area whereas *Chesacardium* is broadly arched. *Dinocardium* is more trigonal in outline and its ribs are wider, slightly lower, and marked with prominent concentric cross-threads. Interiorly the ribs are more visible on *Dinocardium* and the hinge plate is more massive. Just anterior to the cardinal teeth in *Dinocardium*, the hinge plate is reflected upward, and becomes attached to the beak. This hinge-plate modification is only weakly expressed in *Chesacardium*, and it does not reflect upward or attach to the beak.

The two genera, *Chesacardium* and *Dinocardium*, co-occur in the Miocene and Pliocene on the Atlantic Coastal Plain. *Chesacardium* thrived in the temperate to subtropical range while *Dinocardium* occupied subtropical to tropical settings. The two genera occur together in the Raysor Formation of South Carolina (upper Pliocene), where their ranges overlapped. *Chesacardium* made its first appearance in the Calvert Formation in Maryland and is a major component of the faunas of the Choptank, St. Marys, Eastover, and Yorktown Formations. The genus apparently did not survive the post-Yorktown cooling event and is not known from later stratigraphic units. There is no present-day taxon that occupies this temperate niche. *Dinocardium* continues to flourish from Virginia southward. Some of the taxa assigned to *Chesacardium* are the following:

C. leptopleura (Conrad)—Calvert Formation
C. craticuloides (Conrad)—Calvert Formation
C. laqueatum blackwelderi new subspecies—Choptank Formation
C. laqueatum vostreysi new subspecies—Choptank Formation
C. laqueatum eshelmani new subspecies—St. Marys Formation
C. laqueatum laqueatum (Conrad)—St. Marys Formation
C. laqueatum blountense (Mansfield)—Eastover Formation
C. acutilaqueatum (Conrad)—Yorktown Formation

Etymology.—*Chesacardium* receives its name from the Chesapeake Group, in which it is well represented.

Type information.—Type species: *Cardium laqueatum* Conrad, 1830. The Conrad type material housed at the Academy of Natural Sciences of Philadelphia contained no specimens of *C. laqueatum* as of December 1985, and Richards (1968) did not record the species in the collections. I designate the topotype specimen illustrated here (Plate 8, figure 9) from the St. Marys River the neotype of *C. laqueatum*. It is on this species that I base the genus *Chesacardium*. The neotype is USNM 405250. Type locality: Conrad (1830, p. 259) stated that his specimen came from

"the clay beds at St. Mary's River," Md.. This appears to be a description of the locality where the neotype was collected; below Chancellor Point, on the left bank of the St. Marys River, St. Marys County, Md. (locality 13, USGS locality 24785).

Figured specimen.—Plate 8, figure 9, neotype (a topotype) (USNM 405250), from below Chancellor Point, St. Marys River, St. Marys County, Md.

Stratigraphic and geographic range.—Calvert, Choptank, St. Marys, and Eastover Formations of Maryland and Virginia. Eastover Formation of Virginia and North Carolina. Yorktown Formation of Virginia and North Carolina. Duplin Formation of North and South Carolina. Raysor Formation of South Carolina. Lower Miocene to upper Pliocene.

Chesacardium laqueatum laqueatum (Conrad, 1830)
Plate 8, figure 9

Cardium laqueatum Conrad, 1830, p. 258–259.
Cardium laqueatum Conrad. Conrad, 1838, p. 31–32, Pl. XVII, fig. 1. [In part].
Cardium ingens Dall, 1898*a*, p. 10, Pl. 3, fig. 2.
Cardium (*Cerastoderma*) *laqueatum* (Conrad). Glenn, 1904, p. 319–320. [In part].
Cerastoderma laqueatum (Conrad) Conrad. Gardner, 1943, p. 90. [In part].
Cerastoderma laqueatum (Conrad). Vokes, 1957, p. 16. [In part].
Laevicardium (*Dinocardium*) *laqueatum* (Conrad). Glibert and van de Poel, 1970, p. 38.
Cerastoderma chancellorensis Oleksyshyn, 1959, p. 31, 32, Pl. 3, figs. 3, 4.
Cardium laqueatum (Conrad). Ward and Powars, 1989, p. 36, Pl. 10, fig. 9.

Discussion.—Conrad's (1830) original specimens came from beds now called the St. Marys Formation on the St. Marys River. His later (Conrad, 1838) description also included additional specimens from the Patuxent River, Md.. These additional specimens probably came from the Drumcliff Member of the Choptank Formation at Jones Wharf, Patuxent River, St. Marys County, Md. Conrad considered the two forms to be identical, but the Choptank form is herein considered to be a new subspecies of C. *laqueatum*. *Chesacardium l. laqueatum* has more, narrower, higher, and less flattened ribs than its Choptank counterpart, C. *laqueatum blackwelderi*. The two taxa are similar in tumidity but the Choptank form is more evenly rounded and more prosocline. The form in the Drumcliff Member of the Choptank Formation is herein described and named C. *laqueatum blackwelderi*, new subspecies. The specimen that Oleksyshyn (1959) named *Cerastoderma chancellorensis* is considered to be a juvenile of C. *laqueatum* and measures 22 mm in height.

Type information.—Neotype: USNM 405250. Type locality: The neotype comes from below Chancellor Point, on the left bank of the St. Marys River, St. Marys County, Md. (locality 13). Type information concerning the type species and neotype is discussed in the description of the new genus *Chesacardium* (see page XXX).

Figured specimen.—Neotype (USNM 405250), a right valve and topotype specimen.

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene), Maryland and Virginia.

Chesacardium laqueatum blountense (Mansfield, 1932)
Plate 3, figure 4

Cardium (*Cerastoderma*) *laqueatum blountense* Mansfield, 1932, p. 112, Pl. 22, figs. 6, 10.
Cerastoderma laqueatum (Conrad). Gardner, 1943 [1944], p. 90. [In part].

Discussion.—*Chesacardium laqueatum blountense* is similar to C. *laqueatum laqueatum* but differs in being more tumid in the umbones, in having thinner, flatter, and more widely sparated ribs, and in having a more quadrate form, due partly to its angular, abrupt posterior shoulder. The holotype came from the "Arca zone" at Vaughan Creek, Walton County, Fla. (USGS locality 12046), presumably from the Red Bay Formation (Akers, 1972). The specimen from the Cobham Member of the Eastover Formation figured here agrees well with Mansfield's (1932) type material from Florida.

Type information.—Holotype: USNM 371618. Type locality: "Station 12046 [USGS], Vaughan Creek, upper locality, Walton County, Fla." (Mansfield, 1932, p. 112).

Figured specimen.—Right valve (USNM 405251) from 2.7 km below Bowlers Wharf, right bank of the Rappahannock River, Essex County, Va. (locality 2).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia; Red Bay Formation (upper Miocene) in Florida.

Chesacardium laqueatum eshelmani, new subspecies
Plate 12, figure 2

Cardium (*Cerastoderma*) *laqueatum* Conrad. Glenn, 1904, p. 319–320. [In part].

Cerastoderma laqueatum (Conrad). Gardner, 1943 [1944], p. 90. [In part].

Cerastoderma laqueatum (Conrad). Vokes, 1957, p. 16. [In part].

Diagnosis.—Shell large, moderately inflated, subovate, anteriorly and posteriorly produced, noticeably prosocline.

Description.—Shell large, moderately inflated for the genus, subovate in outline but slightly angular with a sharply produced anterior and posterior margin. Exterior sculpture consists of 42 thin, moderately high radial ribs with narrow interspaces. Ribs nearly smooth, rounded, and crossed by very fine concentric lamellae. Ventral margin sub-rounded, tapering sharply to a flattened posterior slope and shoulder. Anterior margin rounded sharply. Beaks low for the genus. Exterior elongate outline reflected interiorly, creating a long, relatively straight hinge plate. Hinge plate on right valve (holotype) with strong elongate anterior and posterior lateral teeth and accompanying sockets, and a weak anterior cardinal and strong posterior cardinal with an intervening socket. Anterior and posterior adductor muscle scars subovate, distinct. Pallial line distinct proximal to the muscle scars, less distinct or obscure distal to the scars. Interior of valve smooth with only the ventral margin fluted to correspond to exterior ribbing.

Discussion.—*Chesacardium l. eshelmani* is clearly closely related to *C. laqueatum laqueatum* but differs in being less tumid, more prosocline, and more elongate. *Chesacardium l. eshelmani* is common in the silty sands of the Little Cove Point beds of the St. Marys Formation. The taxon is named in honor of Ralph E. Eshelman, past director of the Calvert Marine Museum in Solomons, Md.

Type information.—Holotype: USNM 405252. Type locality: One kilometer (0.6 miles) south of Little Cove Point, western shore of the Chesapeake Bay, Calvert County, Md., in the Little Cove Point beds of the St. Marys Formation (locality 15).

Figured specimen.—Holotype (USNM 405252), a right valve.

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland.

Chesacardium laqueatum vostreysi, new subspecies
Plate 15, figure 6

Cardium (*Cerastoderma*) *laqueatum* Conrad. Glenn, 1904, p. 319–320. [In part].

Cerastoderma laqueatum (Conrad). Gardner, 1943 [1944], p. 90. [In part].

Cerastoderma laqueatum (Conrad). Vokes, 1957, p. 16. [In part].

Diagnosis.—Shell large, tumid, subovate, with 43 very thin, sharp, high ribs.

Description.—Shell large, broadly inflated with tumid umbones. Outline of shell sub-rounded. Exterior sculpture consisting of 43 (in the holotype) very narrow, sharp, high ribs with wider interspaces. Very feeble concentric striae discernible in the interspaces, producing some small nodes where they cross the ribs. The hinge plate moderate for the genus with strong lateral teeth, a moderate anterior cardinal and a weak posterior cardinal (in the holotype, a left valve). Anterior and posterior muscle scars deeply impressed with the pallial line distinct proximal to the scars, less so distally. Interior of valve smooth except on the ventral margin, where it is fluted to correspond to the exterior ribbing.

Discussion.—*Chesacardium laqueatum vostreysi* is distinct from *C. l. eshelmani* in being much more ovate in outline and by having thinner, sharper ribs. *Chesacardium l. vostreysi* is closely related to *C. l. blackwelderi*, but the fine, thin, sharp ribbing of *C. l. vostreysi* is very different from the wide, flat, low ribbing of *C. l. blackwelderi*. *Chesacardium l. vostreysi* is common but usually poorly preserved in the Boston Cliffs Member of the Choptank Formation (Bed 19) in the vicinity of the type locality.

Etymology.—The taxon receives its name from Robert Vostreys, who was one of the directors of the Maryland Academy of Sciences, Calvert Cliffs Project in 1968–1969.

Type information.—Holotype: USNM 405253. Type locality: Baltimore Gas and Electric Atomic Power Plant site, western shore of the Chesapeake Bay, Calvert County, Md. (locality 17).

Figured specimen.—Holotype (USNM 405253), a left valve.

Stratigraphic and geographic range.—Choptank Formation, Boston Cliffs Member (upper middle Miocene) in Maryland.

Chesacardium laqueatum blackwelderi, new subspecies
Plate 17, figure 4

Cardium (*Cerastoderma*) *laqueatum* Conrad. Glenn, 1904, p. 319–320 (in part), Pl. LXXXVI, fig. 1.

Cerastoderma laqueatum (Conrad). Gardner, 1943 [1944], p. 90 (in part), Pl. 16, fig. 4.

Cerastoderma laqueatum (Conrad). Vokes, 1957, p. 16 (in part), Pl. 12, fig. 7.

Diagnosis.—Shell large, tumid, subovate, with 38 radial ribs that are flat posteriorly and medially and becoming rounded anteriorly.

Description.—Shell large, broadly inflated with tumid umbones. Outline of shell sub-rounded. Exterior sculpture consisting of 38 radial ribs. Ribs broad and flat with narrower interspaces posteriorly and medially. Ribs thinner with equally wide interspaces anteriorly. Fine concentric lamellae in the interspaces medially but very subdued on ribbing. Concentric lamellae producing nodes on ribs anteriorly and on the extreme posterior region. Posterior shoulder rounded. Beaks low but showing wear where the two valves touch when open. Interior margin broadly rounded with moderately strong hinge plate. Anterior lateral tooth strong, elongate, sharp; posterior lateral weak. Anterior cardinal strong, sharp; posterior cardinal small. Anterior and posterior adductor muscle scars distinct but weakly impressed. Pallial line very weak, apparent only proximal to posterior adductor scar. Interior of valve very smooth. Ventral shell margin fluted to correspond to exterior ribbing.

Discussion. — *Chesacardium l. blackwelderi* differs from *C. l. vostreysi* in having fewer, wider, lower, and flatter ribs. The two taxa otherwise are closely similar. *Chesacardium l. blackwelderi* is common to abundant in the sands of the Drumcliff Member of the Choptank Formation in Calvert and St. Marys Counties, Md. where it is usually found with much-abraded ribs. The subspecies is named for Blake W. Blackwelder.

Type information.—Holotype: USNM 405254. Type locality: Drumcliff, on the right bank of the Patuxent River, St. Marys County, Md. (locality 16).

Figured specimen.—Holotype (USNM 405254), a left valve.

Stratigraphic and geographic range.—Choptank Formation, Drumcliff Member (middle middle Miocene) in Maryland. Calvert Formation, Calvert Beach Member (lower middle Miocene) in Maryland and Virginia.

Chesacardium craticuloides (Conrad, 1845)
Plate 21, figure 5

Cardium craticuloides Conrad, 1845, p. 66, Pl. XXXVII, fig. 3.

Cardium (*Cerastoderma*) *craticuloides* Conrad. Conrad, 1863*b*, p. 576.

Cardium (*Cerastoderma*) *craticuloides* Conrad. Whitfield, 1894, p. 66, Pl. X, fig. 19.

Cardium (*Cerastoderma*) *craticuloide* Conrad. Glenn, 1904, p. 320–321, Pl. LXXXVI, fig. 3.

Cerastoderma craticuloide (Conrad). Vokes, 1957, p. 16, Pl. 12, fig. 5.

Discussion.—*Chesacardium craticuloides* is the earliest known representative of the genus. The taxon is small for the genus but has the characteristic subovate form, is deep-valved, and is ornamented with the typical thin, high, radiating ribs. Another small cardiid, *Chesacardium*(?) *leptopleura* (Conrad, 1841), co-occurs with *C. craticuloides* in Bed 10 of the Plum Point Marl Member. In most respects it is like typical *Chesacardium* taxa, but its ribs are V-shaped in cross-section. This may or may not be a restricting characteristic, but *C.*(?) *leptopleura* is provisionally included in the new genus *Chesacardium*.

Type information.—Type: Richards (1968) did not list *C. craticuloides* in the Academy of Natural Sciences of Philadelphia. This author found a left valve of a specimen of *C. craticuloides* in Conrad's type lot of *Cardium leptopleura*. It is the same size and general form as Conrad's (1845, Pl. XXXVII, fig. 3) figure of *C. craticuloides*, but it is the opposite valve. The single valve may have been in Conrad's type lot and later become displaced. I herein designate Conrad's specimen as neotype of *Cardium craticuloides*. It bears the number ANSP 30625 (the same number as "*Cardium*" *leptopleura*). Type locality: "Calvert Cliffs, Md." (Conrad, 1845, p. 66).

Figured specimen.—Neotype (ANSP 30625), a left valve.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland.

Genus *Dinocardium* Dall, 1900

Discussion.—Dall (1900, p. 1097, 1098) included *Dinocardium taphrium* under his "Section *Dinocardium*." The genus *Dinocardium* has wide, flat ribs with raised arcuate imbrications where the concentric lamellae intersect the ribs. In this respect and the reflected part of the hinge plate which touches the

beaks, *Dinocardium* differs from *Chesacardium* (see description of *Chesacardium*). Members of the genus seems to be restricted to sub-tropical to tropical marine settings.

Dinocardium taphrium Dall, 1900
Plate 25, figure 3

Cardium (*Cerastoderma*) *taphrium* Dall, 1900, p. 1098, Pl. 40, fig. 9.
Cardium (*Cerastoderma*) *taphrium* Dall. Dall, 1915, p. 144, Pl. 19, fig. 3.
Cardium (*Cerastoderma*) *taphrium* Dall. Gardner, 1926*c*, p. 139, Pl. XXIII, fig. 7.
Cardium taphrium Dall. Cooke and Mossom, 1929, p. 99, Pl. 11, fig. 1.
Cardium (*Cerastoderma*) *taphrium* Dall. Mansfield, 1932, p. 113.

Discussion.—*Dinocardium taphrium* is very small for the genus but exhibits all the characteristics of that taxon. The taxon is common but usually fragmentary in the Haywood Landing Member of the Belgrade Formation.

Type information.—Holotype: USNM 135879. Type locality: "Oligocene of the Ballast Point silex beds, Tampa Bay(?)," Florida (Dall, 1900, p. 1098).

Figured specimen.—Left valve (USNM 405255) from Belgrade, Onslow County, N.C. (locality 29).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina. Tampa Limestone (upper Oligocene and lower Miocene) in Florida.

Superfamily MACTROIDEA Lamarck, 1809
Family MACTRIDAE Lamarck, 1809
Subfamily MACTRINAE Lamarck, 1809
Genus *Mactrodesma* Conrad, 1869

Mactrodesma subponderosa (d'Orbigny, 1852)
Plate 9, figures 4, 6; Plate 12, figure 6

Mactra ponderosa Conrad, 1830, p. 228, Pl. X, fig. 5.
Mactra ponderosa Conrad. Conrad, 1838, p. 25–26, Pl. XIV, fig. 1.
Mactra subponderosa d'Orbigny, 1852, p. 114, no. 2133.
Mactra ponderosa Conrad. Conrad, 1863*b*, p. 572.
Mactrodesma ponderosa (Conrad). Conrad, 1869*a*, p. 247.
Spisula (*Hemimactra*) *subponderosa* (d'Orbigny). Dall, 1898*b*, p. 899–900, Pl. 27, figs. 3, 16.
Spisula (*Hemimactra*) *subponderosa* (d'Orbigny). Glenn, 1904, p. 288–289, Pl. LXX, figs. 1–4.
Spisula (*Hemimactra*) *subponderosa* (d'Orbigny). Vokes, 1957, p. 21–22, Pl. 18, figs. 6, 7.
Mactrodesma subponderosa (d'Orbigny). Ward and Powars, 1989, p. 37, Pl. 11, figs. 4, 6.

Discussion.—Orignially named *Mactra ponderosa* by Conrad (1830), this taxon was later renamed *M. subponderosa* by d'Orbigny (1852) because Conrad's name was preoccupied. *Mactrodesma subponderosa* is unique in its very large size and very thick shells. The genus and the species are similar in general outline to *Hemimacra solidissima* (Dillwyn), but *M. subponderosa* is higher in outline, much more convex, much thicker, and has shorter, stouter anterior and posterior lateral teeth. *Mactrodesma subponderosa* appears in the Little Cove Point beds of the St. Marys Formation and is common in that unit and the Windmill Point beds of the same formation, from whence the type material came. There are no known members of this lineage in older or younger beds.

Type information.—Lectotype: ANSP 30497. There are seven valves of *M. subponderosa* in Conrad's type material. It is not certain which two valves are figured. I have chosen one right valve as lectotype. Type locality: "It is numerous at St. Marys River" (Conrad, 1830, p. 228), St. Marys County, Md.

Figured specimen.—Plate 9, figure 4: Right valve (USNM 405256) from Windmill Point, St. Marys River, St. Marys County, Md. (locality 12). Plate 9, figure 6: Left valve (USNM 405257) from the same locality; both topotype specimens. Plate 12, figure 6: Right valve (USNM 405258) from below Little Cove Point, on the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland and Windmill Point beds (lower upper Miocene) in Maryland and Virginia.

Genus *Leptomactra*, new genus

Diagnosis.—Shell of moderate size, compressed, subtriangular, somewhat arcuate, very thin, with very fine incremental lines, and delicate dentition.

Description.—Shell of moderate size, thin, fragile, ovate-trigonal in outline, medially compressed, slightly sulcate posteriorly. Umbones moderately inflated with a sharp prosgyrate beak. Lunule poorly defined but elongate in depression in front of umbones. Very slightly depressed behind the umbones. Posterior area demarked by a distinct, low thin ridge, behind which the shell texture is somewhat rougher and irregular.

Anterior to ridge, the exterior is sculptured by many very thin, low, concentric incremental lines. Anterior and ventral margin broadly rounded. Posterior margin angular where it meets the postero-dorsal slope. Hinge-plate thin, supporting very thin elongate posterior and anterior non-striated lateral teeth and corresponding thin, deep sockets. Chondrophore large, deep, triangular, with a posterior inclination. Right posterior cardinal tooth thin, small, intersecting with somewhat larger, thin anterior cardinal. Resulting V-shaped socket is receptacle for single, small, sharply projecting V-shaped cardinal tooth on the left valve. Adductor muscle scars distinct, subovate, subequal, but not deeply impressed. Pallial line not conspicuous, with a large elliptical sinus just anterior to the posterior muscle scar. Interior of valve smooth with interior margin entire.

Etymology.—From the Greek, *leptos*, meaning thin, delicate.

Discussion.—Taxa that are herein included in *Leptomactra* have most often been placed in the subgenus *Hemimactra*. *Hemimactra* differs in having a more oval outline, lower beaks, striated lateral teeth, and more distinct pallial line and muscle scars. *Hemimactra* also lacks the convex lunular area of *Leptomactra*. Species assigned to *Leptomactra* are the following:

L. marylandica (Dall)
L. delumbis (Conrad)—Genotype
L. dodona (Dall)
L. vaihiniera (Gardner)
L. curtidens (Dall) = *Spisula (Hemimactra?) chesapeakensis* Glenn
L. harrisi (Olsson)

Type information.—Type species: The type species is based on Conrad's (1832) taxon *Mactra delumbis*, the type of which is in the Academy of Natural Sciences of Philadelphia (ANSP 30532) (Richards, 1968). Type locality: "James River, near Smithfield" (Conrad, 1832, p. 26).

Stratigraphic and geographic range.—Middle and upper Miocene, lower and upper Pliocene, Maryland to Florida.

Leptomactra delumbis (Conrad, 1832)
Plate 8, figure 8

Mactra delumbis Conrad, 1832, p. 26, Pl. 11.
Mactra delumbis Conrad. Conrad, 1838, p. 27, Pl. XV, fig. 1.
Mactra virginiana Conrad, 1868, p. 269, Pl. 22, fig. 4.
Mactra (Schizodesma) delumbis Conrad. Whitfield, 1894, p. 82–83, Pl. XV, fig. 10.
Spisula (Hemimactra) delumbis (Conrad). Dall*b*, 1898, p. 897, Pl. 27, fig. 26.
Spisula (Hemimactra) delumbis (Conrad). Glenn, 1904, p. 286–287, Pl. LXIX, fig. 10.
Spisula (Hemimactra) delumbis (Conrad). Mansfield, 1932, p. 152–153, Pl. 32, fig. 18.
Mactra delumbis Conrad. Richards and Harbison, 1942, p. 196–197, Pl. 15, figs. 16, 17.
Spisula delumbis (Conrad). Blackwelder, 1981, p. 15, Pl. 3, fig. 4.
Mactra delumbis (Conrad). Ward and Powars, 1989, p. 36, Pl. 10, fig. 8.

Discussion.—*Leptomactra delumbis* makes its first known appearance in the Windmill Point beds of the St. Marys Formation (lower upper Micoene) and its last known appearance in the Moore House Member of the Yorktown Formation (upper Pliocene). The earliest forms of the species are relatively small (approximately 65 mm in length) and have a sharper posterior ridge than the Yorktown forms, which commonly reach 100 mm in the area of the type locality on the James River at Morgarts Beach, Isle of Wight County, Va.

Type information.—Type: ANSP 30532. Type locality: "James River, near Smithfield" (Conrad, 1832, p. 26), Isle of Wight County, Va.

Figured specimen.—Left valve (USNM 405259) from below Chancellor Point, St. Marys River, St. Marys County, Md. (locality 13).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland and Virginia. Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia. Yorktown Formation, Rushmere, Morgarts Beach, and Moore House Members (upper Pliocene) in Virginia. Jackson Bluff Formation (upper Pliocene) in Florida.

Leptomactra marylandica (Dall, 1898)
Plate 17, figures 3, 5

Spisula (Hemimactra) marylandica Dall, 1898*b*, p. 897, Pl. 28, fig. 5.
Spisula (Hemimactra) marylandica Dall. Glenn, 1904, p. 287, Pl. LXIX, fig. 11.
Spisula (Hemimactra) marylandica Dall. Vokes, 1957, p. 22, Pl. 19, fig. 1.

Discussion.—*Leptomactra marylandica* is more tumid than *L. delumbis* and its ventral margin more broadly rounded. In other respects the two are very similar.

Leptomactra marylandica is common and large in the Drumcliff Member of the Choptank Formation. A smaller, flatter, less tumid variety of the taxon is present in the Windmill Point beds of the St. Marys Formation where it co-occurs with the first known specimens of *L. delumbis*. These minor differences may be due to the muddier substrate conditions in the Windmill Point beds.

Gardner (1928) commented that *L. valhosierr* (Gardner, 1928) from the Oak Grove of Florida is very similar to *L. marylandica*.

Type information.—Type: USNM 153782. Type locality: Jones Wharf, Patuxent River, St. Marys County, Md.

Figured specimen.—Topotype specimen, a right valve (USNM 405260) from Drumcliff (Jones Wharf), on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Choptank Formation, Drumcliff Member (Bed 17) (middle middle Miocene) in Maryland. St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland.

Genus *Spisula* Gray, 1837

Discussion.—The following two mactrid taxa are here included under the umbrella name "*Spisula*" only for lack of knowledge of their respective lineages. Both species appear to represent distinctive new genera and may be assigned that status when more is known about them.

"*Spisula*" *rappahannockensis* (Gardner, 1944)
Plate 3, figures 5, 6

Spisula (Hemimactra) rappahannockensis Gardner, 1943 [1944], p. 110–111, Pl. 18, figs. 2–4, 7.

Spisula rappahannockensis Gardner. Blackwelder and Ward, 1976, p. 45, Pl. 2, figs. 4, 5.

Spisula rappahannockensis (Gardner). Ward and Blackwelder, 1980, Pl. 3, figs. 5, 6.

Spisula rappahannockensis (Gardner). Ward, 1984, Pl. 11, figs. 5, 6.

Spisula rappahannockensis (Gardner). Ward, 1985*b*, Pl. 11, figs. 5, 6.

Spisula rappahannockensis (Gardner). Ward, 1985*c*, Pl. 11, figs. 5, 6.

Spisula rappahannockensis (Gardner). Ward, 1987, p. 138, Pl. 11, figs. 5, 6.

Spisula rappahannockensis (Gardner). Ward, 1989, p. 88, Pl. 11, figs. 5, 6.

Spisula rappahannockensis (Gardner). Ward and Powars, 1989, p. 40, Pl. 15, figs. 5, 6.

Discussion.—This small taxon is about the same size as *Mulinia lateralis* (Say) and probably occupied the same niche as that species—that is, in muddy, quiet, inner bay or back-barrier marginal marine settings. "*Spisula*" *rappahannockensis* was most common in the inner portions of the Eastover embayment, where it occurred in countless numbers, dominating both in terms of biomass as well as specimens. The taxon has a distinctive shape and hinge and probably deserves new generic status. This status may be given when its phylogenetic relationships are more clear. It differs from "S." *subcuneata* in being much thicker, more equilateral, and being only slightly prosocline in outline.

Type information.—Holotype: USNM 325601. Type locality: 0.6–1.2 km below Bowlers Wharf on the Rappahannock River, Essex County, Va. (Vicinity of locality 2 of this report).

Figured specimen.—Plate 2, figure 5: Left valve (USNM 258368) from 2.7 km below Bowlers Wharf on the Rappahannock River, Va. (locality 2). Plate 2, figure 6: A right valve (USNM 258369) from the same locality.

Stratigraphic and geographic range.—Eastover Formation (upper Miocene) in Virginia. Some molds and casts of the taxon in the Eastover in Maryland and North Carolina.

"*Spisula*" *subcuneata* (Conrad, 1838)
Plate 11, figure 4

Mactra subcuneata Conrad, 1838, p. 28, Pl. XV, fig. 3.

Mactra clathrodon Lea. Glenn, 1904, p. 286, Pl. LXIX, figs. 7–9. [Not M. *clathrodon* of Lea, 1833].

Discussion.—"*Spisula*" *subcuneata* was figured and identified as *Mactra clathrodon* Lea by Glenn (1904), but the latter species is a very small form, probably from the Yorktown Formation in Virginia and not Maryland as reported by Lea (1833). "*Spisula*" *subcuneata* is common to abundant in the silty sands of the Little Cove Point beds of the St. Marys Formation in Maryland, especially in the vicinity of Little Cove Point (locality 15). The taxon does not seem to fit under any of the existing mactrid genera and may deserve a new generic name. It is distinguished by its small, very thin, delicate shell. In that respect and its prosocline beak, it differs from "S." *rappahannockensis*.

Type information.—Lectotype: Conrad's type lot of "S." *subcuneata* at the Academy of Natural Sciences of Philadelphia (ANSP 30609) contains two left valves and one right valve. Conrad (1838, Pl. XV, fig. 3) figured the exterior of a right valve and the interior of a left valve. I herein select the right valve as lectotype. Type locality: "St. Mary's River, Maryland."

Figured specimen.—A left valve (USNM 405262) from below Little Cove Point, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland.

Superfamily TELLINOIDEA de Blainville, 1814
Family TELLINIDAE de Blainville, 1814
Subfamily MACOMINAE Olsson, 1961
Genus *Florimetis* Olsson and Harbison, 1953

Florimetis biplicata (Conrad, 1834)
Plate 16, figure 4

Tellina biplicata Conrad, 1834, p. 152.
Metis biplicata Conrad. Conrad, 1840, p. 36, Pl. XIX, fig. 4.
Metis biplicata Conrad. Conrad, 1863*b*, p. 573.
Metis biplicata Conrad. Dall, 1900, p. 1042. [In part].
Metis biplicata Conrad. Glenn, 1904, p. 301, Pl. LXXIII, figs. 5, 6.
Metis biplicata (Conrad). Richards and Harbison, 1942, p. 196, Pl. 12, figs. 2, 3.
Apolymetis biplicata (Conrad). Vokes, 1957, p. 20, Pl. 17, figs. 14, 15.
Gastrana (*Leporimetis*) *biplicata* (Conrad). Glibert and van de Poel, 1967, p. 117.
Florimetis biplicata (Conrad). Ward and Powars, 1989, p. 34, Pl. 8, fig. 4.
Not—
Tellina biplicata of Tuomey and Holmes, 1856, p. 88, Pl. XXII, fig. 3.
Tellina biplicata of Emmons, 1858, p. 296, fig. 225.

Discussion.—This morphologically distinctive taxon is present in the Calvert and St. Marys Formations and is very common in the Drumcliff Member of the Choptank Formation. The form referred to *Metis biplicata* by Tuomey and Holmes (1856) and Emmons (1858) was named *Metis magnoliana* by Dall (1900) and is a valid species in the Pliocene deposits of Virginia, North Carolina, and South Carolina.

Type information. — Type: ANSP 30595. Type locality: Choptank River, Md.

Figured specimen.—Right valve (USNM 405263) from Drumcliff on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Calvert, Choptank, and St. Marys Formations (middle and upper Miocene) in Maryland.

Family DONACIDAE Fleming, 1828
Genus *Donax* Linné, 1758

Donax idoneus Conrad, 1872
Plate 25, figure 9

Donax idoneus Conrad, 1872, p. 216, Pl. 7, fig. 2.
Donax idoneus Conrad. Richards, 1943, p. 522, Pl. 84, figs. 1, 2.
Donax idoneus Conrad. Richards, 1950, p. 76, fig. 66b,c.
Donax idoneus Conrad. Carter et al., 1988, p. 82, Pl. 7, fig. 58.

Discussion.—Conrad (1872) realized that this was probably a fossil species that was being eroded from a Miocene bed below sea level and mixed with Holocene taxa on the beach near Beaufort, N.C. It has since been collected, in place, in the lower Miocene beds near Silverdale, Onslow County, N.C. *Donax idoneus* Conrad is large and thick for the genus and is common in the Haywood Landing Member of the Belgrade Formation.

Type information.—Richards (1968) does not list this taxon from among Conrad's types at the Academy of Natural Sciences of Philadelphia, and it may be lost. The specimen figured herein (Plate 25, figure 8) is designated the neotype. Type locality: "Coast of North Carolina, probably from a Miocene-bed under the sea" (Conrad, 1872, p. 216). Dimensions of the neotype: Length, 39.9 mm; height, 27.4 mm.

Figured specimen.—Neotype, a right valve (USNM 405264) from the Martin Marietta Company Belgrade Quarry, Belgrade, Onslow County, N.C. (locality 29).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene), in North Carolina.

Superfamily ARCTICOIDEA Newton, 1891
Family EULOXIDAE Gardner, 1944
Genus *Euloxa* Conrad, 1863

Euloxa latisulcata (Conrad, 1839)
Plate 3, figure 9; Plate 6, figure 5

Venus latisulcata Conrad, 1839, 3rd page of new cover.

Venus latisulcata Conrad. Conrad, 1840, p. 40–41, Pl. XX, fig. 6.
Euloxa latisulcata (Conrad). Conrad, 1863*b*, p. 578.
Euloxa (Venus) latisulcata (Conrad). Conrad, 1863*c*, p. 585.
Euloxa latisulcata (Conrad). Conrad, 1872, p. 52–53, Pl. I, fig. 5.
Euloxa latisulcata (Conrad). Dall, 1903, p. 1502.
Euloxa latisulcata (Conrad). Gardner, 1943 [1944], p. 65–66, Pl. 15, figs. 1, 2.
Euloxa latisulcata (Conrad). Nicol, 1953, p. 56–61, figs. 2, 3, 6–8.
Euloxa latisulcata (Conrad). Ward and Blackwelder, 1980, Pl. 1, fig. 9; Pl. 3, fig. 3.
Euloxa latisulcata (Conrad). Ward, 1984, p. 63, Pl. 9, fig. 9; Pl. 11, fig. 3.
Euloxa latisulcata (Conrad). Ward, 1985*b*, Pl. 9, fig. 9; Pl. 11, fig. 3.
Euloxa latisulcata (Conrad). Ward, 1985*c*, Pl. 9, fig. 9; Pl. 11, fig. 3.
Euloxa latisulcata (Conrad). Ward, 1987, p. 136, Pl. 9, fig. 9; p. 138, Pl. 11, fig. 3.
Euloxa latisulcata (Conrad). Ward, 1989, p. 86, Pl. 9, fig. 9; p. 88, Pl. 11, fig. 3.
Euloxa latisulcata (Conrad). Ward and Powars, 1989, p. 39, Pl. 13, fig. 9; p. 41, Pl. 15, fig. 3.
Euloxa latisulcata (Conrad). Ward, *in* Johnson et al., 1990, Pl. 9, fig. 9; Pl. 11, fig. 3.

Discussion.—Once thought to be rare (Gardner, 1943 [1944]), this species has been found by Nicol (1953) and the present author in many outcrops of the Eastover Formation. It is common to abundant in the Claremont Manor Member but is usually poorly preserved. The shell is characterized by a conspicuous, deep fold or sinus on the posterior slope from the umbones to the ventral margin. In this characteristic the taxon is unique and its higher taxonomic affinities questionable.

Type information.—Lectotype: ANSP 19546, selected by Nicol (1953). Type locality: "Near Urbanna, Va." [Middlesex County].

Figured specimen.—Plate 3, figure 9: Left valve (USNM 258366) from Cobham Wharf, Surry County, Va. (locality 3). Plate 6, figure 5: Left valve (USNM 258355) from below the mouth of Chippokes Creek on the James River, Surry County, Va. (USGS loc. 26042).

Stratigraphic and geographic range.—Eastover Formation, Claremont Manor and Cobham Bay Members (upper Miocene) in Virginia.

Superfamily GLOSSOIDEA Gray, 1847
Family GLOSSIDAE Gray, 1847
Genus *Glossus* Poli, 1795

Glossus fraterna (Say, 1824)
Plate 6, figure 1

Isocardia fraterna Say, 1824, p. 143–144, Pl. XI, fig. 1.
Isocardia conradi d'Orbigny, 1852, p. 121, no. 2273. [In part].
Bucardia fraterna Say. Conrad, 1863*b*, p. 576.
Isocardia fraterna Say. Heilprin, 1884*b*, p. 98.
Isocardia fraterna Say. Dall, 1900, p. 1066–1067.
Isocardia carolina Dall, 1900, p. 1067–1069, Pl. 46, fig. 22.
Isocardia fraterna Say. Gardner, 1943 [1944], p. 67, Pl. 11, fig. 15.
Isocardia fraterna carolina Dall. Gardner, 1943 [1944], p. 67–68, Pl. 11, fig. 5; Pl. 23, fig. 39.
Glossus fraternus (Say). Mongin, 1959, p. 320. [In part].
Glossus fraternus carolinus (Dall). Mongin, 1959, p. 320, Pl. 27, fig. 4a–d.
Glossus fraterna (Say). Ward and Blackwelder, 1980, Pl. 1, fig. 8.
Glossus fraterna (Say). Ward, 1984, p. 63, Pl. 9, fig. 8.
Glossus fraterna (Say). Ward, 1985*b*, Pl. 9, fig. 8.
Glossus fraterna (Say). Ward, 1985*c*, Pl. 9, fig. 8.
Glossus fraterna (Say). Ward, 1987, p. 136, Pl. 9, fig. 8.
Glossus fraterna (Say). Ward, 1989, p. 86, Pl. 9, fig. 8.
Glossus fraterna (Say). Ward and Powars, 1989, p. 39, Pl. 13, fig. 8.
Glossus fraterna (Say). Ward, *in* Johnson, 1990, Pl. 9, fig. 8.
Not—
Isocardia fraterna (Say). Glenn, 1904, p. 317–318, Pl. LXXXV, figs. 3, 4.

Discussion.—This taxon differs from other *Glossus* in being larger and very globose and in lacking the pronounced ridge down the posterior slope that is present in G. *marylandica* (Schoonover) and G. *santamaria*, n. sp. It was apparently a temperate form and was most abundant in the Claremont Manor Member of the Eastover Formation and the Sunken Meadow Member of the Yorktown Formation. Its presence in the Raysor Formation in South Carolina is believed to reflect temperate conditions which preceded the later subtropical setting.

Type information.—Type: BM(NH) L13202. Type locality: Said to be "Maryland" but is probably the bluffs along the York River near Yorktown, Va. See discussion on *Rasia arata* (Say).

Figured specimen.—Left valve (USNM 258354) from just below the mouth of Upper Chippokes Creek on the James River, Surry County, Va. (USGS locality 26042).

Stratigraphic and geographic range.—Eastover For-

mation (upper Miocene) and Yorktown Formation in Virginia (lower and upper Pliocene). Yorktown Fomation in North Carolina (lower and upper Pliocene). Raysor Formation in South Carolina (upper Pliocene).

Glossus santamaria new species
Plate 7, figure 6

Isocardia fraterna var. *marylandica* Schoonover, 1941, p. 57–59. [In part].

Diagnosis.—Shell medium-sized, thick cordate-globose, with irregularly spaced, deep, concentric undulations and a pronounced ridge on the posterior slope.

Description.—Shell thick, heavy for its size, with strongly prosogyrate umbones. Shell strongly arched, cordate-globose, with a sharply angular anterior margin and a subrounded to rounded ventral and posterior margin. Exterior sculpture of profound concentric undulations produced by growth pauses. Fine concentric incremental lines between the undulations are crowded near the ventral margin. Prominent ridge from the beak to the posterior margin, creating a flattened posterior shoulder. Secondary smaller ridge between the posterior margin and the primary ridge. Small depression in front of the primary posterior ridge causes a slight radial undulation. Interiorly the hinge is massive, the ligamental groove is deeply inset, and the teeth large and lamelliform. In the left valve (holotype), the cardinal is elongate and slightly bilobed. The posterior lateral is massive, elongate, and curved with the posterior margin. Anterior adductor muscle scar deeply impressed, semi-lunate, smaller than that of the posterior, and reflected sharply backwards. Posterior muscle scar less well-defined, larger, ovate. Pallial line indistinct, somewhat distant from the ventral margin. Interior of valve smooth and margins entire.

Measurements.—Holotype (USNM 405265) length 54.9 mm, height 58.9 mm, convexity 24.1 mm. Paratype (USNM 405266) length 56.8 mm, height 46.0 mm, convexity 21.0 mm. Paratype (USNM 405267) length 43.9 mm, height 37.2 mm, convexity 17.0 mm.

Discussion.—Schoonover (1941) described the differences between the forms in the St. Marys and Choptank Formations but included both in her new variety (subspecies) *Glossus fraterna marylandica*. *Glossus santamaria* n. sp. has much more profound concentric undulations than do either G. *marylandica* (Schoonover) or G. *fraterna* (Say). In that respect it is similar to G. *markoei* (Conrad) but it is much less tumid and more quadrate in outline than that taxon. *Glossus santamaria*, like all known *Glossus*, is variable in form, but it is less elongate than G. *marylandica* and is more like the globose form of G. *fraterna*. It differs from that taxon, both in its deep concentric undulations and in having the pronounced ridge on the posterior slope. *Glossus santamaria* is common, though never abundant, in the Little Cove Point beds of the St. Marys Formation and has been found in that unit at Windmill Point (locality 12) and Chancellor Point (locality 13) on the St. Marys River, St. Marys County, Md., and in Virginia at Essex Mill, Essex County (locality 14), and White Oak Landing, King William County (locality 8).

Type information.—Holotype: USNM 405265. Type locality: 0.4 km. below Chancellor Point, left bank of the St. Marys River, St. Marys County, Md. (locality 13). Paratype (USNM 405266) is from the same locality. Paratype (USNM 405267) is from 0.5 km. below Windmill Point, right bank of the St. Marys River, St. Marys County, Md. (locality 12).

Figured specimen.—Holotype (USNM 405265), a left valve from the type locality.

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (upper middle Miocene) in Maryland and Virginia.

Glossus marylandica (Schoonover, 1941)
Plate 18, figure 4

Isocardia rustica Sowerby. Conrad, 1838, p. 20, Pl. XI, fig. 1. [In part].

Isocardia conradi d'Orbigny, 1852, p. 121, no. 2273. [In part].

Isocardia fraterna Say. Glenn, 1904, p. 317–318, Pl. LXXXV, fig. 3, 4.

Isocardia fraterna var. *marylandica* Schoonover, 1941, p. 221–223, Pl. 9, figs. 4–6; Pl. 10, figs. 4, 6.

Isocardia fraterna glenni Gardner, 1943 [1944], p. 68, Pl. 16, figs. 1, 2.

Isocardia fraterna var. *marylandica* Schoonover. Vokes, 1957, p. 16, Pl. 13, figs. 1, 2.

Glossus fraternus marylandicus (Schoonover). Mongin, 1959, p. 320–321.

Not—

Isocardia conradi Gabb, 1860, p. 393, Pl. 86, fig. 21.

Isocardia conradi Gabb. Whitfield, 1885, p. 200–201, Pl. XXVI, figs. 3, 4.

Isocardia conradi Gabb. Weller, 1907, p. 599–600, Pl. LXVI, figs. 13–14.

Discussion.—It is clear that Conrad's (1838) description of *Isocardia rustica* was based principally on specimens of *Glossus fraterna* (Say) from the Yorktown Formation in Virginia and North Carolina, as was his figure, although he did refer to a locality on the "Patuxent River, and near Charlotte Hall, Maryland" (p. 20). For that reason d'Orbigny's name *Isocardia conradi* should fall into synonomy with G. *fraterna* as it was based on Conrad's (1838, Pl. XI, fig. 1) figure. Schoonover (1941, p. 221) pointed out that *Isocardia fraterna* var. *marylandica* differed from typical G. *fraterna* in being smaller, less rotund, and more quadrate, and in having the depressed sulcus just anterior to the ridge on the posterior shoulder. It is believed that these differences are sufficient to elevate G. *marylandica* to specific rank. *Glossus marylandica* is abundant in the Calvert Beach Member of the Calvert Formation (Bed 14) and the Drumcliff Member (Bed 17) of the Choptank Formation. It is present, though not abundant, in the Boston Cliffs Member (Bed 19) of the Choptank Formation.

Type information.—Holotype: PRI 3956. Paratypes PRI 3959, 3961, 3957. Type locality: "North of Calvert Beach, Maryland, for a stretch of a little over a mile" (Schoonover, 1941, p. 267) in "Zone" 17 (of Shattuck, 1904), Drumcliff Member of Gernant (1970).

Figured specimens.—Plate 18, figure 4: Left valve (USNM 405268) from Drumcliff, on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Calvert Formation, Calvert Beach Member (lower middle Miocene) in Maryland and Virginia. Choptank Formation, Drumcliff Member (middle middle Miocene) in Maryland, and Boston Cliffs Member (upper middle Miocene) in Maryland and Virginia.

Glossus markoei (Conrad, 1842)
Plate 22, figures 3, 4

Isocardia markoei Conrad, 1842, p. 193, Pl. 2, fig. 1.
Isocardia markoei Conrad. Conrad, 1845, p. 70, Pl. 40, fig. 2.
Bucardia markoei (Conrad). Conrad, 1863*b*, p. 576.
Isocardia markoei Conrad. Heilprin, 1884, p. 78, 98.
Isocardia markoei Conrad. Dall, 1900, p. 1067.
Isocardia markoei Conrad. Glenn, 1904, p. 316–317, Pl. LXXXIV, figs. 2, 3.
Isocardia markoei Conrad. Schoonover, 1941, p. 224, Pl. 10, figs. 1–3.

Discussion.—*Glossus markoei* (Conrad) is a strongly characterized species with profoundly inflated valves, very incurved beaks, and several deeply impressed, concentric undulations. The taxon is present, but not common, in Bed 10 of the Plum Point Marl Member of the Calvert Formation. Glenn (1904) recognized that Conrad (1842) had included two distinct forms under the name *Isocardia markoei*, and he proposed that the form with the more profoundly incurved beaks be called *I. markoei* while the less coiled form be called *I. mazlea*. Both forms are present in Conrad's type lot in the Academy of Natural Sciences of Philadelphia (ANSP 30578), and this author believes that their separation is valid.

Type information.—Lectotype: Conrad's type material (ANSP 30578) consists of five specimens; two right valves and one left valve of *Isocardia markoei* (as restricted by Glenn, 1904) and two right valves of *I. mazlea* (as proposed by Glenn, 1904). I designate the larger right valve in Conrad's type lot of *I. markoei* the lectotype. I further designate Conrad's larger specimen, later called *I. mazlea* Glenn, the lectotype of that species since Glenn did not designate a type. Type locality: "Captain Hance's farm, Calvert Cliffs, Maryland" (Conrad, 1842, p. 193).

Figured specimen.—Right valve (USNM 405269) from Plum Point, on the western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland.

Glossus mazlea (Glenn, 1904)
Plate 22, figures 1, 2

Isocardia markoei Conrad, 1842, p. 193, Pl. 2, fig. 1. [In part].
Isocardia mazlea Glenn, 1904, p. 317, Pl. LXXXIV, figs. 4, 5.
Isocardia mazlea Glenn. Schoonover, 1941, p. 224–225, Pl. 9, figs. 1–3.

Discussion.—*Glossus mazlea* was named by Glenn (1904) on the basis of Conrad's specimens of *Isocardia markoei* (see discussion on G. *markoei*). The new name was proposed for the less coiled form illustrated by Conrad (1842). In addition to differences in the beak, G. *mazlea* has less profound concentric undulations and is less inflated. *Glossus mazlea* is present but never abundant in Bed 10 of the Plum Point Marl Member.

Type information.—Lectotype: Glenn (1904) did not select a holotype; hence, I select Conrad's larger specimen, that Glenn excluded from *I. markoei*, as lectotype. This specimen is in the Academy of Natu-

ral Sciences of Philadelphia (ANSP 30578) in Conrad's type lot of *I. markoei*. Type locality: "Captain Hance's farm, Calvert Cliffs, Maryland" (Conrad, 1842, p. 193).

Figured specimen.—Right valve (USNM 405270) from Plum Point, on the western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland.

Superfamily VENEROIDEA Rafinesque, 1815
Family VENERIDAE Rafinesque, 1815
Subfamily VENERINAE Rafinesque, 1815
Genus *Melosia* Dall, 1915

Melosia staminea (Conrad, 1839)
Plate 21, figure 6

Cytherea staminea Conrad, 1839, p. 3 of cover, [Pl. 21, fig. 1].
Cytherea staminea Conrad, 1840, p. 46, Pl. XXI, fig. 1. [Name only on plate explanation].
Dione staminea Conrad. Conrad, 1863*b*, p. 575.
Cytherea staminea Conrad. Heilprin, 1886, p. 116.
Cytherea (*Artena*) *staminea* Conrad. Dall, 1903, p. 1279.
Venus (*Artena*) *staminea* (Conrad). Whitfield, 1894, p. 72–73, Pl. XIII, figs. 3–10.
Cytherea (*Antigona*) *staminea* Conrad. Glenn, 1904, p. 314, Pl. LXXVI, figs. 6, 7, 8.
Antigona (*Antigona*) *staminea* (Conrad). Palmer, 1927, p. 329, Pl. XXVII, figs. 2, 4, 5, 9, 10, 11, 14.
Antigona (*Antigona*) *staminea* (Conrad). Schoonover, 1941, p. 225–226, Pl. 11, figs. 6–8.
Antigona staminea (Conrad). Richards and Harbison, 1942, p. 194, Pl. 12, figs. 7, 8.
Melosia staminea (Conrad). Vokes, 1957, p. 17, Pl. 14, figs. 6, 7.
Antigona staminea (Conrad). Mongin, 1959, p. 321–323, fig. 11.
Clausinella staminea (Conrad). Glibert and van de Poel, 1967, p. 39.
Melosia staminea (Conrad). Ward, 1984, Pl. 7, fig. 5.
Melosia staminea (Conrad). Ward, 1985*b*, Pl. 7, fig. 5.
Melosia staminea (Conrad). Ward, 1985*c*, Pl. 7, fig. 5.
Melosia staminea (Conrad). Ward, 1987, p. 134, Pl. 7, fig. 5.
Melosia staminea (Conrad). Ward, 1989, p. 84, Pl. 7, fig. 5.
Melosia staminea (Conrad). Ward and Powars, 1989, p. 33, Pl. 7, fig. 5.
Melosia staminea (Conrad). Ward, *in* Johnson et al., 1990, Pl. 7, fig. 5.

Discussion.—*Melosia staminea* (Conrad, 1839) is a small, thick-shelled venerid with high, thin concentric lamellae and very fine intervening concentric incremental lines. The taxon is abundant in Bed 10 of the Plum Point Marl Member of the Calvert Formation and is present as external molds in Bed 2 of the Fairhaven Member of the same formation. Conrad described the species in 1839 but did not figure it until 1840.

Type information.— Type: ANSP 13368. The single specimen in the Conrad collection agrees well with Conrad's later (1840) figure and, according to Moore (1962), was labelled by Conrad. Type locality: "Calvert County, Md." (Conrad, 1839).

Figured specimen.—Left valve (USNM 380697) from Camp Roosevelt on the western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation, Fairhaven Member, Bed 2 (lower Miocene) and Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland.

Subfamily PITARINAE Stewart, 1930
Genus *Macrocallista* Meek, 1876

Macrocallista acuminata Dall, 1903
Plate 25, figures 4, 6

Macrocallista acuminata Dall, 1903, p. 1255, Pl. 57, fig. 3.
Macrocallista (*Paradione*) *acuminata* Dall. Dall, 1915, p. 146, Pl. 20, figs. 8–10; Pl. 24, fig. 2.
Macrocallista acuminata Dall. Gardner, 1926*c*, p. 160, Pl. XXIV, fig. 7.
Macrocallista acuminata Dall. Mansfield, 1937, p. 261.

Discussion.—*Macrocallista acuminata* Dall, 1903 is more angularly produced posteriorly than any of the later forms in the Chesapeake Group. The taxon is common in the Haywood Landing Member of the Belgrade Formation in North Carolina.

Type information.—Holotype: USNM 114631. Type locality: Alum Bluff, Chattahoochee River, Apalachicola, Fla.

Figured specimen.—Right valve (USNM 405271) from Silverdale Marl Company Quarry at Silverdale, Onslow County, N.C. (locality 30).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina. Tampa Limestone (upper Oligocene and lower Miocene) in Florida. Chipola Formation (lower Miocene) in Florida.

Macrocallista marylandica (Conrad, 1833)
Plate 18, figure 1; Plate 22, figure 7

Cytherea marylandica Conrad, 1833, p. 343.
Cytherea marylandica Conrad. Conrad, 1838, p. 15, Pl. IX, fig. 1.
Dione marylandica Conrad. Conrad, 1863*b*, p. 575.
Dione marylandica Conrad. Whitfield, 1894, p. 74, Pl. XIII, fig. 1.
Macrocallista (*Chionella*) *marylandica* Conrad. Dall, 1903, p. 1255–1256.
Macrocallista marylandica (Conrad). Glenn, 1904, p. 311–312, Pl. LXXIV, figs. 1, 2.
Callista (*Callista*) *marylandica* (Conrad). Palmer, 1927, p. 284–285, Pl. XI, figs. 2–3; Pl. XII, figs. 10–11.
Macrocallista marylandica (Conrad). Richards and Harbison, 1942, p. 193, Pl. 10, fig. 13.
Macrocallista marylandica (Conrad). Vokes, 1957, p. 19, Pl. 16, figs. 1, 2.
Callista marylandica (Conrad). Mongin, 1959, p. 323–324.

Discussion.—*Macrocallista marylandica* was named for the form that occurs abundantly in the Choptank Formation. In that unit it reaches a very large size and considerable thickness. The forms found in the Calvert Formation are usually much smaller and thinner and proportionately more elongate, but this may be a function of ecologic factors. *Macrocallista* is extremely rare in the St. Marys Formation, a single valve having been found at Langleys Bluff in the Little Cove Point beds. That well-preserved specimen is clearly not M. *marylandica*, being shorter, thinner, more compressed, and more rounded. True M. *marylandica*, then, are believed to be restricted to the Choptank Formation and are abundant in the Drumcliff Member (Bed 17) and the Boston Cliffs Member (Bed 19). Specimens from the Plum Point Marl Member (Bed 10) of the Calvert are provisionally assigned the name M. *marylandica* until a full suite of sizes is available for comparison.

Type information.—Richards (1968) did not list *Macrocallista marylandica* from Conrad's types in the Academy of Natural Sciences of Philadelphia, nor could the author find the type lot. Moore (1942) cites the type as missing. I herein select my figured specimen (USNM 405272, Plate 18, figure 1) as the neotype. Type locality: "Vastly abundant in the bank of the Choptank River, about four miles from Easton, Md." (Conrad, 1833, p. 343).

Figured specimens.—Plate 18, figure 1: Neotype (USNM 405272), a left valve from below Flag Pond on the western shore of the Chesapeake Bay, Calvert County, Md. (USGS locality 24001), in the Drumcliff Member (Bed 17) of the Choptank Formation. Plate 22, figure 8: USNM 405273 from Camp Roosevelt, on the western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Choptank Formation in Maryland (middle and upper middle Miocene). Possibly Bed 10 of the Plum Point Marl Member of the Calvert Formation (lower middle Miocene).

Subfamily DOSINIINAE Deshayes, 1853
Genus *Dosinia* Scopoli, 1777

Dosinia acetabulum thori, new subspecies
Plate 8, figure 7; Plate 12, figure 1

Artemis acetabulum Conrad, 1832, p. 20. [In part].
Artemis acetabulum Conrad. Conrad, 1838, p. 29–30, Pl. XVI, fig. 1. [In part].
Dosinia acetabulum Conrad. Conrad, 1863*b*, p. 575. [In part].
Dosinia (*Dosinidia*) *acetabulum* Conrad. Dall, 1903, p. 1230–1231. [In part].
Dosinia acetabulum Conrad. Glenn, 1904, p. 315, Pl. LXXXIII, fig. 1; Pl. LXXXIV, fig. 1. [In part].
Dosinia acetabulum (Conrad). Palmer, 1927, p. 271–273 [in part], Pl. 19, figs. 1, 3, 9.
Dosinia (*Dosinidia*) *acetabulum* (Conrad). Gardner, 1943 [1944], p. 120–122. [In part; not Pl. 11, fig. 4].
Dosinia acetabulum (Conrad). Vokes, 1957, p. 17 [in part], Pl. 13, figs. 3, 4.
Dosinia acetabulum (Conrad). Ward and Powars, 1989, p. 36, Pl. 10, fig. 7.

Diagnosis.—Shell moderately large, discoidal, moderately inflated, with numerous small concentric grooves, at first very regular, becoming somewhat irregular.

Description.—Shell moderately large, somewhat friable, nearly discoidal in outline, prosocline, moderately inflated, and thin. Brown coloration marks remnants of periostracum in many specimens. Exterior covered by numerous, finely impressed, concentric grooves that are very regular in the young stages and become more distant and irregular in the adult. Medially the grooves are less well defined and tend to fuse in the adults. Posterior slope very weakly rounded, remainder of margin nearly evenly rounded. Lunule small, thin, impressed, escutcheon absent, beak sharp, umbones subcentral. Interiorly, ligamental area large, elongate, sickle-shaped, striated. Resilial pit small, moderately deep, oval in shape. Hinge plate broad, somewhat straight and moderately heavy.

Teeth in the right valve (holotype, USNM 405274) consist of a very thin, small anterior cardinal, a strong medial cardinal, proximal to the anterior cardinal, and a stronger, obliquely angled, somewhat bifid, elongate posterior cardinal. Teeth in the left valve are divergent and widely separated. Very small anterior lateral tooth, only a small protuberance in the left valve and a shallow socket in the right valve. Muscle scars distinct, pallial line less so. Anterior adductor muscle scar large, roundly lanceolate. Posterior scar larger, ovate. Pallial line weakly impressed and somewhat distant from the ventral margin. Pallial sinus narrow, sharply V-shaped. Interior surface smooth except for low linear undulations within the area delineated by the pallial line.

Dimensions of the holotype (USNM 405274): Length 79.0 mm, height 72.0 mm, convexity 17.9 mm.

Discussion.—Conrad's (1832, p. 20) original description and figure of *D. acetabulum* were clearly of a Yorktown Formation form, even though he listed the species from the following localities: "St. Mary's River, and Easton, Md; James River, near Smithfield, and Suffolk, Va." The types are missing from the Academy of Natural Sciences of Philadelphia, but the figured specimen, by its large size, strongly prosocline outline, and large resilial pit, can be confidently identified as coming from the Yorktown. I herein restrict the name *Dosinia a. acetabulum* to the taxon from the Yorktown Formation. The type is missing and I herein designate a left valve (USNM 382131) as the neotype of *D. a. acetabulum*. That specimen is a topotype from Morgarts Beach, right bank of the James River, Isle of Wight County, Va. (James River, near Smithfield) (USGS loc. 26114) and came from the Morgarts Beach Member of the Yorktown Formation. The specimen was collected by the author and has been illustrated by Blackwelder and Ward (1979, Pl. 1, fig. 5) and by Blackwelder (1981, p. 16, Pl. 4, fig. 2). Measurements of the neotype are: Height 78.2 mm, length 81.9 mm, convexity 18.7 mm.

Dosinia acetabulum thori differs from *D. acetabulum acetabulum* in being more circular and less prosocline, and in having a straighter, less-arched hinge line. *Dosinia a. acetabulum* has a more massive hinge, is noticeably produced posteroventrally, and has a much larger resilial pit, and its pallial sinus is obtusely rounded.

The new subspecies is named for Thor Hansen, who was at George Washington University when he collected the specimen herein designated the holotype.

Type information.—Holotype: USNM 405274. Type locality: Above Windmill Point, right bank of the St. Marys River, St. Marys County, Md. (locality 12).

Figured specimen.—Plate 8, figure 7: Neotype (USNM 405274) a right valve from the type locality. Plate 12, figure 1: Neotype (USNM 405275) from below Little Cove Point, on the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland and Windmill Point beds (lower upper Miocene) in Maryland and Virginia.

Dosinia acetabulum blackwelderi, new subspecies
Plate 18, figure 2

Artemis acetabulum Conrad, 1832, p. 20 [in part]; not Pl. 6, fig. 1.

Artemis acetabulum Conrad. Conrad, 1838, p. 29–30 [in part]; not Pl. XVI, fig. 1.

Dosinia acetabulum Conrad. Conrad, 1863*b*, p. 575. [In part].

Dosinia (Dosinidia) acetabulum Conrad. Dall, 1903, p. 1230–1231. [In part].

Dosinia acetabulum Conrad. Glenn, 1904, p. 315 [in part]; not Pl. LXXXIII, fig. 1 or Pl. LXXXIV, fig. 1.

Dosinia acetabulum (Conrad). Palmer, 1927, p. 271–273 [in part], Pl. 19, fig. 7.

Diagnosis.—Shell moderately large, subovate, higher than long, moderately inflated, with numerous, small, concentric grooves, at first regular, becoming irregular and somewhat fused medially and distally.

Description.—Shell moderately large, friable, subovate in outline, moderately prosocline, moderately inflated, and thin. Brown coloration marks remnants of periostracum in many specimens. Exterior covered by numerous, finely impressed, concentric grooves that are very regular in the young stages but become fused medially and distally in the adult. Posterior slope nearly evenly rounded, ventral margin produced resulting in a form that is higher than long. Lunule small, deeply impressed, escutcheon absent, beak very sharp, umbones nearly central. Interiorly, ligamental area large, elongate, sickle-shaped, striate. Resilial pit small, thin, shallow (somewhat eroded in holotype). Hinge plate broad, heavy, and profoundly arched. The teeth in the right valve (paratype, USNM 405277) consist of three cardinals and a very shallow socket for the anterior lateral of the left valve. The

anterior cardinal is very thin, small, and proximal to the robust, longer medial cardinal. The posterior cardinal is large, somewhat distant from that of the medial and is shallowly bifid. Teeth in the left valve (holotype, USNM 405276) are divergent and widely separated. Anterior cardinal thin and small, medial cardinal stout and low, and posterior cardinal thin and short. Anterior lateral tooth only a small, low protuberance. Muscle scars and pallial line distinct. Anterior adductor muscle scar slightly smaller than that of posterior, both deeply impressed. Pallial line moderately impressed with a moderately wide, sharply V-shaped pallial sinus. Interior of shell smooth except for low linear undulations within the area delimited by the pallial line.

Measurements.—Holotype (USNM 405276): length 73.7 mm, height 75.0 mm, convexity 17.9 mm. Paratype (USNM 405277): length 72.0 mm, height 71.5 mm, convexity 17.2 mm.

Discussion.—*Dosinia acetabulum blackwelderi* differs from *D. acetabulum acetabulum sensu stricto* by being generally smaller, less prosocline, and proportionately higher, with a sharper, more medially placed beak. *Dosinia a. blackwelderi* differs from *D. a. thori* in having a higher, more narrow, oval outline and a more profoundly curved hinge area.

Dosinia a. blackwelderi is most easily distinguished by its almost teardrop or oval outline, which is best developed in adults. Juvenile outlines approach the general shape of *D. a. thori* but can still be differentiated by their higher outline. The taxon is present in the Calvert Formation, Plum Point Marl Member (Bed 10), but is most common in the Choptank Formation, in both the Drumcliff and Boston Cliffs Members.

Type information.—Holotype: USNM 405276. Type locality: Drumcliff (Jones Wharf) on the right bank of the Patuxent River, St. Marys County, Md. (locality 16). Paratype: USNM 405277, from the same locality.

Figured specimen.—Holotype (USNM 405276), a left valve from the type locality.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member (upper lower and lower middle Miocene) and Calvert Beach Member (lower middle Miocene) in Maryland. Choptank Formation, Drumcliff, St. Leonard, and Boston Cliffs Members (middle middle and upper middle Miocene) in Maryland.

Subfamily CLEMENTIINAE Frizzell, 1936
Genus *Clementia* Gray, 1842

Clementia inoceriformis (Wagner, 1839)
Plate 12, figure 3

Venus inoceriformis Wagner, 1839, p. 51–52, Pl. 1, fig. 1.
Venus inoceriformis Wagner. Conrad, 1845, p. 70, Pl. 40, fig. 1.
Clementia inoceriformis Wagner. Conrad, 1863*b*, p. 575.
Clementia inoceriformis Wagner. Dall, 1903, p. 1235–1236.
Clementia inoceriformis (Wagner). Glenn, 1904, p. 315–316, Pl. LXXXII, figs. 1, 2.
Clementia (Egesta) inoceriformis (Wagner). Woodring, 1926, p. 38–39, Pl. 15, figs. 5, 6.
Clementia inoceriformis (Wagner). Palmer, 1927, p. 411–412, Pl. XXV, figs. 10, 13; Pl. XXVI, fig. 13a. [Plates published in 1929].
Clementia inoceriformis (Wagner). Richards and Harbison, 1942, p. 194, fig. 4 (p. 175).

Discussion.—*Clementia inoceriformis* is apparently a warm-water form. Other species of the genus are confined principally to tropical and subtropical areas. It appeared first in the Calvert Formation, though it was rare in those beds as well as in the Choptank Formation. The taxon is a common form in the St. Marys Formation in both the Little Cove Point and Windmill Point beds. Its distinctive exterior sculpture of concentric undulations and its prosocline outline make the species readily identifiable.

Type information.—Holotype: Designated by Woodring (1926, p. 38–39, Pl. 15, figs. 5, 6), ANSP 4303. Type locality: "Banks of St. Mary's River, Maryland . . . obtained on a visit to Porto Bello, on St. Mary's River, Maryland" (Wagner, 1839, p. 51–52).

Figured specimen.—Right valve (USNM 405278) from below Little Cove Point on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member (uncommon) (lower middle Miocene), in Maryland. Kirkwood Formation (lower Miocene) in New Jersey. Choptank Formation, Boston Cliffs Member (Bed 19) (upper middle Miocene) (very rare) in Maryland. St. Marys Formation, Conoy Member (lower upper Miocene ?) (rare); Little Cove Point beds (lower upper Miocene) (common); Windmill Point beds (lower upper Miocene) (common) in Maryland.

Subfamily CHIONINAE Frizzell, 1936
Genus *Anomalocardia* Schumacher, 1817

Anomalocardia floridana (Conrad, 1846)
Plate 25, figure 8

Venus floridana Conrad, 1846, p. 400, unnumbered figure on p. 400.
Anomalocardia floridana Conrad. Dall, 1903, p. 1303–1304, Pl. 55, fig. 14, 15.
Anomalocardia floridana Conrad. Dall, 1915, p. 150, Pl. 23, figs. 4, 5.
Chione (*Anomalocardia*) *floridana* (Conrad). Palmer, 1927, p. 372, Pl. XLIII, figs. 5, 16, 18, 24, 25, 26.

Discussion.—Specimens of this taxon from the Haywood Landing Member of the Belgrade Formation differ slightly from the figures given by Conrad (1846), Dall (1903, 1915), and Palmer (1927) in that they show a shallow sulcus just anterior to the sharp posterior slope. This may be just morphologic variation, or it may indicate that the Belgrade form is a different taxon. The species is common, but not abundant, in the Haywood Landing Member.

Type information.—Conrad's (1846) type of *Venus floridana* has not been found among his types in the Academy of Natural Sciences of Philadelphia (Richards, 1968) and is presumed lost. Type locality: "Ballast Point, Tampa Bay" (Conrad, 1846) [Florida].

Figured specimen.—Left valve (USNM 405279) from Martin Marietta Company Quarry, Belgrade, Onslow County, N.C. (locality 29).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina. Tampa Limestone (upper Oligocene and lower Miocene) in Florida.

Genus *Chione* Megerle von Mühlfeld, 1811

Chione spada Dall, 1903
Plate 25, figure 7

Chione (*Chamelea*) *spada* Dall, 1903, p. 1301, Pl. LV, fig. 13.
Chione (*Chamelea*) *spada* Dall. Dall, 1915, p. 149, Pl. 24, fig. 12.
Chione (*Chamelea*) *spada* Dall. Palmer, 1927, p. 369, Pl. XLI II, fig. 37.
Chione (*Chamelea*) *spada* Dall. Mansfield, 1937, p. 268.

Discussion.—This taxon is common but never abundant in the Haywood Landing Member of the Belgrade Formation.

Type information.—Holotype: USNM 109240. Type locality: Ballast Point, Tampa Bay, Fla.

Figured specimen.—Left valve (USGS 405280) from Martin Marietta Company Quarry, Belgrade, Onslow County, N.C. (locality 29).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina. Tampa Limestone (upper Oligocene and lower Miocene) in Florida.

Genus *Lirophora* Conrad, 1863

Lirophora vredenburgi, new species
Plate 3, figure 7

Diagnosis.—Shell of moderate size, thickness, and convexity for the group, sculptured by moderately strong, thickened or recurved, concentric ribs.

Description.—Shell of moderate size for the genus, thick, heavy, trigonal. Disk sculptured by varying numbers (eight on the holotype) of concentric ribs, somewhat distant, thick, and of low profile in the younger stages (first three ribs), becoming recurved carinae in the later stages (in the holotype). Finely impressed incremental lines apparent in the interspaces and on the base of the ribs. No radial ornamentation apparent except in the deeper shell structure where the ribs have been eroded or broken. Ribs slightly flexed at the anterior and posterior extremities. Ribs terminating abruptly at the escutcheon and at the lunule. Lunule deeply impressed, cordate, with thin, well-defined incremental lines continuing from the ribs. Escutcheon thin, defined by a sharp keel on the posterior slope, and continuing from the beak to the ventro-posterior angular extremity.

Hinge plate massive, sharply curved, with three cardinal teeth and one posterior lateral in the right valve. Cardinal teeth widely divergent with a thin, sharp anterior cardinal, a massive, thick, triangular medial cardinal, and an elongate, thin posterior cardinal that parallels the deeply incised ligamental groove. Traces of the ligament still preserved on the holotype. Posterior lateral teeth long, thin, and continuing to the postero-ventral extremity. Posterior lateral just ventral to a corresponding socket that accommodates the lateral in the left valve. Interior of valve adjacent to lunule minutely crenulated. Small,

but slightly more elongate crenulations on anterior ventral margin, which probably are present along the remainder of the ventral margin (that portion is abraded on the holotype). Paratype with minute crenulations on the ventral margins. Anterior and posterior adductor muscle scars subovate, moderate and nearly equal in size. Pallial line very shallowly impressed, distant from the ventral margin. Pallial sinus very small, obtuse, indistinct.

Measurements.—Holotype (USNM 405281): Length 24.7 mm, height 21.7 mm, convexity 7.9 mm. Paratype (USNM 405282): Length 29.8 mm, height 25.7 mm, convexity 9.0 mm.

Discussion.—*Lirophora vredenburgi*, new species, differs from *L. alveata* (Conrad, 1830) in being thinner, more triangular, less prosocline, and more finely sculpted, and in having considerably lower concentric ribs. Some specimens of *L. vredenburgi* exhibit sharp, thin, recurved ribs, while others have fused, broadly rounded ribs. *Lirophora vredenburgi* is much more robust than *L. dalli* (Olsson, 1914), from which it differs by being thicker, proportionately higher, and more convex, and in having much heavier concentric ribbing.

Etymology.—The species is named in honor of Eric Vredenburg, who, while a student at Old Dominion University, assisted the author.

Type information.—Holotype: USNM 405281. Type locality: Mouth of Whiting Creek, on the right bank of the Rappahannock River, Middlesex County, Va. Paratype: USNM 405282; from 1.3 km below the mouth of Sunken Meadow Creek, right bank of the James River, Surry County, Va. (locality 7).

Figured specimen.—Holotype (USNM 405281).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Lirophora dalli (Olsson, 1914)
Plate 6, figure 6

Chione dalli Olsson, 1914, p. 57, Pl. 3, figs. 7–9.
Chione (*Chione*) *dalli* Olsson. Palmer, 1927, p. 370–371, Pl. XLI, figs. 1, 2, 6.
Chione (*Chamelea*) *dalli* Olsson. Gardner, 1943 [1944], p. 129–130, Pl. 19, figs. 10–11.
Lirophora dalli (Olsson). Ward and Blackwelder, 1980, Pl. 1, fig. 6.
Lirophora dalli (Olsson). Ward, 1984, Pl. 9, fig. 6.
Lirophora dalli (Olsson). Ward, 1985*b*, Pl. 9, fig. 6.
Lirophora dalli (Olsson). Ward, 1985*c*, Pl. 9, fig. 6.
Lirophora dalli (Olsson). Ward, 1987, p. 136, Pl. 9, fig. 6.
Lirophora dalli (Olsson). Ward and Powars, 1989, p. 39, Pl. 13, fig. 6.
Lirophora dalli (Olsson). Ward, *in* Johnson et al., 1990, Pl. 9, fig. 6.

Discussion.—*Lirophora dalli* is distinctly different from the species in the Windmill Point beds of the St. Marys Formation, *L. alveata* (Conrad, 1830), and the species in the Cobham Bay Member of the Eastover Formation, *L. vredenburgi*, n. sp., by being much smaller, thinner, and more compressed, and in having more and much weaker concentric ribbing. *Lirophora dalli* is common in the Claremont Manor Member, especially from Claremont to Cobham Wharf in Surry County, Va.

Type information.—Holotype: PRI 3499. Type locality: James River at Claremont Wharf, Va.

Figured specimen.—Right valve (USNM 258352) from Cobham Wharf, Surry County, Va. (locality 3).

Stratigraphic and geographic range.—Eastover Formation, Claremont Manor Member (upper Miocene) in Virginia.

Lirophora alveata (Conrad, 1830)
Plate 7, figure 7

Venus alveata Conrad, 1830, p. 264–265, Pl. XI, figs. 14–15.
Venus alveata Conrad. Conrad, 1838, p. 9, Pl. V, fig. 2.
Circumphalus (*Lirophora*) *alveatus* (Conrad). Conrad, 1863*b*, p. 575.
Chione (*Lirophora*) *alveata* (Conrad). Dall, 1903, p. 1298.
Chione alveata (Conrad). Glenn, 1904, p. 310–311, Pl. LXXVI, figs. 1–3.
Chione (*Lirophora*) *alveata* (Conrad). Palmer, 1927, p. 379, Pl. XLI, figs. 5, 8, 9, 20, 36, 40.
Chione (*Lirophora*) *alveata* (Conrad). Vokes, 1957, p. 18, Pl. 15, figs. 6, 8.

Discussion.—*Lirophora alveata* is characterized by its thick, sharply ribbed shell and is common to abundant in the Windmill Point beds of the St. Marys Formation. It differs from *L. vredenburgi*, n. sp., in being thicker-shelled and more prosocline and in having fewer and thicker ribs. The two taxa do seem, however, to be closely related.

Type information.—Syntypes: ANSP 30558. Moore (1962) cited "8 possible syntypes" and said that they were labelled by Conrad but the figured specimen was not recognized. Reported as syntypes by Richards (1968). Not among Conrad's types examined at the Academy of Natural Sciences of Philadelphia by the author. Type locality: "Fossil from Maryland" (Conrad, 1830, p. 264); "fossil from the St. Mary's River, Maryland" (p. 265).

Figured specimen.—Right valve (USNM 405283) from above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland.

Lirophora parkeria (Glenn, 1904)
Plate 18, figures 6, 7

Chione parkeria Glenn, 1904, p. 310, Pl. LXXVI, figs. 9–11.
Chione (*Lirophora*) *parkeria* Glenn. Palmer, 1927, p. 171, Pl. XLI, figs. 10, 22, 28. [Plates published in 1929].
Chione parkeria Glenn, Vokes, 1957, p. 18, Pl. 14, figs. 4, 5.

Discussion.—This taxon occurs in large numbers in Bed 12 of the Plum Point Marl Member and Bed 14 of the Calvert Beach Member of the Calvert Formation. It is characterized by its very low, flat, concentric ribbing, which is sharply different from the robustly ribbed *Lirophora latilirata* (Conrad, 1841) and *L. alveata* (Conrad, 1830).

Type information.—Type: USNM 360167, a topotype, is herein chosen to be the lectotype. Type locality: Parker Creek, 3.2 km south of Parker Creek (Glenn, 1904, p. 310). The species occurs in Bed 12 of the Plum Point Marl Member, Bed 14 of the Calvert Beach Member, and is best preserved in Bed 14 from Parker Creek to Governor Run, on the western shore of the Chesapeake Bay, Calvert County, Md.

Figured specimen.—Plate 18, figure 6: Right valve (USNM 405284) from above Scientists Cliffs, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 18). Plate 18, figure 7: Left valve (USNM 405285) from the same locality.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 12 (lower middle Miocene) in Maryland and Calvert Beach Member, Bed 14 (lower middle Miocene) in Maryland and Virginia.

Lirophora latilirata (Conrad, 1841)
Plate 23, figure 5

Venus latilirata Conrad, 1841, p. 28.
Venus latilirata Conrad. Conrad, 1842*a*, p. 183.
Venus latilirata Conrad. Conrad, 1845, p. 68, Pl. 38, fig. 3.
Circumphalus (*Lirophora*) *latiliratus* Conrad. Conrad, 1863*b*, p. 575.
Chione (*Lirophora*) *latilirata* (Conrad). Dall, 1903, p. 1298–1299, Pl. 42, fig. 3. [In part].
Chione latilirata (Conrad). Glenn, 1904, p. 309–310, Pl. LXXVII, figs. 3, 4, 6. [Not fig. 5].
Chione (*Lirophora*) *latilirata* (Conrad). Palmer, 1927, p. 387–389, Pl. XLI, figs. 12, 13, 33; Pl. XLII, fig. 19. [In part].
Chione latilirata (Conrad). Schoonover, 1941, p. 227–228, Pl. 11, figs. 3, 4; Pl. 12, figs. 1–3.
Chione latilirata (Conrad). Richards, 1947, p. 26, Pl. 13, figs. 12, 13.
Chione (*Lirophora*) *latilirata* (Conrad). Vokes, 1957, p. 18, Pl. 15, figs. 4, 7.
Lirophora latilirata (Conrad). Ward, 1984, Pl. 7, fig. 4.
Lirophora latilirata (Conrad). Ward, 1985*b*, Pl. 7, fig. 4.
Lirophora latilirata (Conrad). Ward, 1985c, Pl. 7, fig. 4.
Lirophora latilirata (Conrad). Ward, 1987, p. 134, Pl. 7, fig. 4.
Lirophora latilirata (Conrad). Ward, 1989, p. 84, Pl. 7, fig. 4.
Lirophora latilirata (Conrad). Ward and Powars, 1989, p. 33, Pl. 7, fig. 4.
Lirophora latilirata (Conrad). Ward, *in* Johnson et al., Pl. 7, fig. 4.

Not—

Venus latilirata Conrad. Tuomey and Holmes, 1856, p. 85, Pl. XXI, fig. 12,
Venus latilirata Conrad. Emmons, 1858, p. 293, fig. 219.
Venus latilirata Conrad. Dall, 1900, Pl. 42, fig. 3.
Chione latilirata Conrad. Glenn, 1904, Pl. LXXVII, fig. 5.
Chione latilirata (Conrad). Richards, 1950, p. 77, fig. 68 c, d.
Chione (*Lirophora*) *latilirata* (Conrad). Vokes, 1957, Pl. 15, fig. 5.
Chione latilirata (Conrad). Richards, 1962, p. 64, Pl. 9, figs. 5, 6.
Lirophora latilirata (Conrad). Abbott, 1974, p. 524, taxon number 5874, Pl. 24.

Discussion.—*Lirophora latilirata* has come to be a catch-all name used to include any species of *Lirophora* that has a number of rounded, concentric ribs. *Lirophora latilirata, sensu stricto* is a small, irregularly ribbed taxon that is known only from the Calvert Formation in Maryland and Virginia, and in that unit it is common to abundant only in Bed 10 of the Plum Point Marl Member. It is distinguished by its small size, irregular ribbing, and prosocline outline. It is clearly different from *L. parkeria*, an upper Calvert Formation species, which is larger and less inflated, and has much lower, flatter ribbing. *Lirophora latilirata* is also quite different from the robust *L. alveata* of the St. Marys Formation and the large multi-ribbed *L. vredenburgi*, n. sp. *Lirophora latilirata* is here restricted to the species that occurs only in the Calvert Formation; it differs from the *L. latilirata* (Conrad) of authors (see synonomy) that occurs in the Pliocene, Pleistocene, and Holocene by its small size and irregular ribbing.

Type information.—Type: ANSP 20139. Moore (1962) cited 10 syntypes (ANSP 20139) as present in the type collection, labelled by Conrad, with two specimens subsequently figured. Reported by Richards (1968). Not among Conrad's types examined by the author at the Academy of Natural Sciences of Philadelphia. Type locality: "Medial Tertiary deposits of Calvert cliffs, Maryland" (Conrad, 1841, p. 28) [Calvert County].

Figured specimen.—Right valve (USNM 405286) from Camp Roosevelt, western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland and Virginia.

GENUS *Mercenaria* Schumacher, 1817

Mercenaria druidi Ward, new name
Plate 3, figure 8; plate 6, figure 4

Venus (*Mercenaria*) *berryi* Gardner, 1943 [1944], p. 133–134, Pl. 21, figs. 1–6. [Not *Venus berrii* Wood, 1828].

Mercenaria sp. Ward and Blackwelder, 1980, Pl. 1, fig. 3; Pl. 3, fig. 4.

Mercenaria sp. Ward, 1984. Pl. 9, fig. 3; Pl. 11, fig. 4.

Mercenaria sp. Ward, 1985*b*, Pl. 9, fig. 2; Pl. 11, fig. 4.

Mercenaria sp. Ward, 1985*c*, Pl. 9, fig. 3; Pl. 11, fig. 4.

Mercenaria sp. Ward, 1987, p. 136, Pl. 9, fig. 3; p. 138, Pl. 11, fig. 4.

Mercenaria sp. Ward, 1989, p. 86, Pl. 9, fig. 3; p. 88, Pl. 11, fig. 4.

Mercenaria sp. Ward and Powars, 1989, p. 39, Pl. 13, fig. 3; p. 41, Pl. 15, fig. 4.

Mercenaria sp. Ward, *in* Johnson et al., 1990, Pl. 9, fig. 3; Pl. 11, fig. 4.

Discussion.—*Venus (Mercenaria) berryi* Gardner (1943 [1944]) is preoccupied by *Venus berrii* Wood (1828). Gardner's species is here renamed *Mercenaria druidi* in honor of Druid Wilson (National Museum of Natural History, Washington, D.C.), who pointed out the existence of Wood's (1828) name. *Mercenaria druidi* is common to abundant in the Eastover Formation in Virginia and occurs in some areas with the concentric lamellae fused (Pl. 2, fig. 4) and in some areas where they are not (Pl. 5, fig. 3). Gardner (1943 [1944]) fully described the taxon, and no further description is necessary. *Mercenaria druidi* is smaller and less massive than M. *tetrica* from the St. Marys Formation.

Type information.—Holotype: USNM 325574. *Mercenaria druidi*, new name is based on the description and holotype of Gardner (1943 [1944], p. 133, Pl. 21, figs. 1–3). Type locality: "2F to 3 miles below Bowlers Wharf, Essex County, Va."

Figured specimens.—Plate 3, figure 8: Left valve (USNM 258367) from Urbanna Creek, just above Urbanna, Middlesex County, Va. (USGS locality 26029). Plate 6, figure 4: Left valve (USNM 258349) from just above the mouth of Sunken Meadow Creek, right bank of the James River, Surry County, Va. (USGS locality 26041).

Stratigraphic and geographic range.—Eastover Formation, Claremont Manor and Cobham Bay Members (upper Miocene) in Virginia and North Carolina.

Mercenaria tetrica (Conrad, 1838)
Plate 7, figure 2

Venus tetrica Conrad, 1838, p. 7–8, Pl. IV, fig. 1.

Mercenaria tetrica (Conrad). Conrad, 1863*b*, p. 574.

Venus campechiensis Gmelin. Dall, 1903, p. 1315–1318. [In part].

Venus campechiensis var. *tetrica* (Conrad). Glenn, 1904, p. 307, Pl. LXXX, fig. 2; Pl. LXXXI, fig. 2.

Venus campechiensis tetrica (Conrad). Palmer, 1927, p. 397, Pl. XXXV, figs. 6, 8.

Discussion.—*Mercenaria tetrica* (Conrad) is distinguished by its massive, thick valves, its very prosocline outline, and its numerous, very fine, deeply impressed, concentric striae.

Type information.—Lectotype: ANSP 4136. Conrad's type material of *Mercenaria tetrica* consists of two individuals retaining both valves. The smaller specimen is clearly not from the St. Marys Formation and is probably a M. *rileyi* from the Yorktown Formation, introduced later by mistake. The larger specimen is, without any doubt, from the St. Marys Formation on the St. Marys River, but the valves are somewhat smaller than those depicted by Conrad (1838, Pl. IV, fig. 1). The larger specimen in the presumed type lot is here designated the lectotype of M. *tetrica*. Type locality: "St. Mary's river, Maryland" (Conrad, 1838, p. 7).

Figured specimen.—Right valve (USNM 405287) from above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland and Virginia.

Mercenaria tetrica ssp.(?)
Plate 12, figure 7

Discussion.—*Mercenaria tetrica* ssp.(?) is closely allied with M. *tetrica* in the Windmill Point beds but differs in being thinner and more compressed and in lacking the well-developed concentric striae of that taxon. Exterior sculpture of the subspecies(?) consists of very fine concentric incremental lines that, on some specimens, fuse to produce a relatively smooth exterior. The two taxa do share the same general outline, and both exhibit the somewhat arched posterior slope, which contrasts sharply with the straight, angular posterior slope of M. *cuneata* ssp.(?). The overall shape of M. *cuneata* ssp.(?), another form in the Little Cove Point beds, is much more trigonal and angular, and its valves are much thicker and more inflated.

Figured specimen.—Left valve (USNM 405288) from below Little Cove Point, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland.

Mercenaria cuneata ssp.(?)
Plate 12, figure 5

Venus mortoni Conrad. Conrad, 1838, p. 8, Pl. V, fig. 1. [In part].

Venus campechiensis var. *mortoni* (Conrad). Glenn, 1904, p. 307–308, Pl. LXXVII, figs. 1, 2.

Venus campechiensis cuneata (Conrad). Palmer, 1927, p. 188–189, Pl. XXXIV, fig. 3. [In part]. (Plates pub. in 1929).

Discussion.—*Mercenaria cuneata* ssp.(?) differs from M. *cuneata* only in being somewhat smaller and in fusing its concentric lamellae. Otherwise the two species are similar, if not identical, in outline and form. *Venus mortoni* Conrad (renamed *V. submortoni* by d'Orbigny) is based on a living species, which was collected in Charleston Harbor, S.C., and is not the Miocene taxon. Conrad (1838) included some of the specimens from the St. Marys River in *Venus mortoni* but the two taxa are very different. *Mercenaria cuneata* ssp.(?) is most abundant in the Little Cove Point beds of the St. Marys Formation, where it co-occurs with M. *tetrica* ssp.(?), and it is replaced by M. *tetrica* (Conrad, 1838) in the Windmill Point beds of the St. Marys.

Figured specimen.—Right valve (USNM 405289) from below Little Cove Point, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland.

Mercenaria cuneata Conrad, 1869
Plate 18, figure 3

Mercenaria cuneata Conrad, 1869*b*, p. 278, Pl. 20, fig. 1.

Mercenaria plena Conrad, 1869*d*, p. 100.

Venus campechiensis var. *cuneata* (Conrad). Glenn, 1904, p. 308, Pl. LXXXII, fig. 3; Pl. LXXXIII, fig. 2.

Venus plena (Conrad). Glenn, 1904, p. 306, Pl. LXXIX, figs. 1, 2.

Venus campechiensis var. *capax* (Conrad). Glenn, 1904, p. 308, Pl. LXXX, fig. 1; Pl. LXXXI, fig. 1.

Venus campechiensis cuneata (Conrad). Palmer, 1927, p. 188–189, Pl. XXXIV, fig. 2. [In part]. (Plates pub. in 1929).

Venus campechiensis capax Conrad. Palmer, 1927, p. 189. [In part].

Venus plena (Conrad). Palmer, 1927, p. 194. [In part; not Pl. XLIV, fig. 22].

Mercenaria plena (Conrad). Vokes, 1957, p. 19, Pl. 3, fig. 1; Pl. 15, fig. 3.

Mercenaria campechiensis var. *capax* (Conrad). Vokes, 1957, p. 18, Pl. 14, fig. 3. [Figured by Glenn as from the Choptank Formation at Cordova, Md.; figured by Vokes as from the St. Marys Formation at the St. Marys River, Md.; Pl. 15, fig. 2].

Discussion.—As can be seen from the synonomy, this taxon has been given several names, and the name "*cuneata*" has been applied to various other species of *Mercenaria*. The Choptank Formation contains two forms: a small, somewhat rounded form, and a large, massive, angularly shouldered form. It is my belief that the two are the same species. The name M. *cuneata* has invariably been applied to the larger form. The names M. *plena* and M. *capax* have been applied to the smaller, rounded form. *Mercenaria cuneata* has priority over M. *plena* by a matter of five months, and M. *capax* is Conrad's (1845) name for a short, rotund, and tumid *Mercenaria* from the Old Church Formation, on the Pamunkey River, New Kent County, Va. (Pl. 25, fig. 5).

Mercenaria cuneata is a large, thick species when an adult, with an angular, posterior slope. It is very common to abundant in the Choptank Formation, especially in the Drumcliff Member (Bed 17) and the Boston Cliffs Member (Bed 19). The subspecies in the

St. Marys Formation, M. *cuneata* ssp., differs only in its slightly smaller size and in the fusing of its concentric lamellae.

Type information.—Palmer (1927, p. 188) reported that the probable type was in the Academy of Natural Sciences of Philadelphia, and she measured the specimen. Moore (1962) noted that syntype specimens were present and were labelled by Conrad. Richards' (1968) list of types in the ANSP did not include M. *cuneata*, and presumably the type material could not be found at that time. Two small specimens labelled M. *plena* are present in Conrad's types at the ANSP. However, in case the two species are separated in the future, I hesitate to use this material to select a neotype. I herein designate the figured specimen (Pl. 18, fig. 3) as the neotype (USNM 405290) until Conrad's type material is found. Type locality: "Charles Co., Maryland" (Conrad, 1869*d*, p. 278).

Figured specimen.—Neotype (USNM 405290) from Drumcliff, on the right bank of the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Calvert Formation, Calvert Beach Member (lower middle Miocene) in Maryland and Virginia. Choptank Formation (middle middle and upper middle Miocene) in Maryland.

Mercenaria blakei, new species
Plate 22, figure 6

Venus rileyi Conrad. Glenn, 1904, p. 304–305, Pl. LXXVI, figs. 4, 5. [Not *V. rileyi* of Conrad (1838)].
Venus mercenaria Linné. Glenn, 1904, p. 305–306, Pl. LXXVIII, figs. 1, 2. [Not *V. mercenaria* of Linné (1758)].
Venus mercenaria Linné. Richards and Harbison, 1942, p. 195, Pl. 13, figs. 3, 4. [Not *V. mercenaria* of Linné (1758)].
Venus plena Conrad. Richards and Harbison, 1942, p. 195, Pl. 13, figs. 1, 2. [Not *V. plena* of Conrad (1869)].
Mercenaria mercenaria (Linné). Vokes, 1957, p. 18, Pl. 14, figs. 1, 2. [Not M. *mercenaria* of Linné (1758)].
Mercenaria rileyi (Conrad). Vokes, 1957, p. 18, Pl. 15, fig. 1. [Not of Conrad (1838)].
Mercenaria sp. Ward, 1984, p. 58, Pl. 7, fig. 7.
Mercenaria sp. Ward, 1985*b*, Pl. 7, fig. 7.
Mercenaria sp. Ward, 1985*c*, Pl. 7, fig. 7.
Mercenaria sp. Ward, 1987, p. 134, Pl. 7, fig. 7.
Mercenaria sp. Ward, 1989, p. 84, Pl. 7, fig. 7.
Mercenaria sp. Ward and Powars, 1989, p. 33, Pl. 7, fig. 7.
Mercenaria sp. Ward, *in* Johnson et al., 1990, Pl. 7, fig. 7.

Diagnosis.—Shell of moderate size, ovate-elongate, thin, compressed, with very finely impressed, concentric lamellae.

Description.—Shell of moderate size, thin, inequilateral, profoundly prosocline with an ovate-elongate outline. Umbones low and not prominent, beaks somewhat prosogyrate. Exterior sculpture on preserved specimen consists of numerous, very fine concentric lamellae separated by equally fine impressed striae. Where the exterior is eroded, fine striae radiate from the beak producing, a cancellate appearance. Lunule is short, moderately wide, and deeply impressed. Escutcheon poorly developed, thin, elongate, and weakly defined by an angulation of the valve along the postero-dorsal shoulder.

Interiorly the ligamental groove is very thin and deeply impressed and sharply separates the exterior of the valve from the hinge plate. Ligamental attachment area long, thin, tapering, and somewhat scimitar-shaped. Ligament very finely and weakly striate. Hinge plate elongate and thin, and supporting four, widely diverging cardinal teeth in the right valve. Anterior cardinal thin, sharp, and protruding with a deep V-shaped socket between it and the anterior-medial cardinal. Anterior and posterior medial cardinals both somewhat bifid with a wide, deep socket between them. Posterior cardinal an elongate, thin, low ridge parallel to the ligamental area, but separated from that structure by a thin, shallow groove. Right valve with a thin, low groove just posterior to the ligamental area which acts as a socket to the corresponding posterior lateral tooth in the left valve. Cardinal teeth in the left valve somewhat heavier than in the right and consisting of a sharp, triangular, projecting anterior cardinal, a somewhat bifid, thick medial cardinal, and an elongate, thin, posterior cardinal. Interior of valve smooth except for some undulations within the limits of the pallial line. Anterior adductor muscle scar lunate, posterior scar subovate; both scars clearly defined, the anterior scar somewhat more deeply impressed than the posterior. Anterior pedal retractor scar very small, deeply impressed, below and just anterior to the anterior cardinal. Posterior pedal retractor scar triangular and adjacent to the posterior adductor. Pallial line clearly defined, impressed, forming the margins of a somewhat raised shelf between that line and the shell margin. Pallial sinus sharply V-shaped. Margins very finely crenulated from the beak to the postero-ventral margin.

The holotype (USNM 405291) is 81.0 mm in length, 61.0 mm in height, and its convexity (single

valve) is 19.9 mm.

Discussion.—The species herein named *Mercenaria blakei* has long been confused with M. *rileyi* (Conrad, 1838) (= M. *tridacnoides* Lamarck, 1818), a species found in the Rushmere, Morgarts Beach, and Moore House Members of the Yorktown Formation, and in general outline it is similar to that taxon. It differs in being smaller, thinner, less robust, and more compressed, and in having a more elongate-ovate shape. The hinge and teeth of M. *rileyi* are more massive than M. *blakei*, and the thin, elongate posterior cardinal seen in M. *blakei* is nearly obsolete in M. *rileyi*.

Etymology.—The species is named in honor of S. F. Blake, formerly of the U.S. Department of Agriculture, who donated extensive collections of mollusks from the Calvert, Choptank, and St. Marys Formations to the National Museum of Natural History.

Type information.—Holotype: USNM 405291. Type locality: Camp Roosevelt, on the western shore of the Chesapeake Bay, Calvert County, Md., in Bed 10 of the Plum Point Marl Member.

Figured specimen.—Holotype (USNM 405291).

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland.

Mercenaria capax (Conrad, 1843)
Plate 25, figure 5

Venus capax Conrad, 1843*b*, p. 324.
Venus capax Conrad. Conrad, 1845, p. 68, Pl. 38, fig. 4.
Mercenaria capax (Conrad). Conrad, 1863*b*, p. 574.
Venus campechiensis capax Conrad. Palmer, 1927, p. 397, Pl. XXXIII, figs. 2, 4, 5. (Plates published in 1929).
Venus gardnerae Kellum. Richards, 1948, p. 5, Pl. 4, fig. 25.
Venus gardnerae Kellum. Richards, 1950, p. 76, fig. 65c.
Mercenaria gardnerae Kellum. Ward, 1984, p. 55, Pl. 6, fig. 8.
Mercenaria gardnerae Kellum. Ward, 1985*a*, p. 54, Pl. 6, fig. 8. [Published March 1986].
Mercenaria gardnerae Kellum. Ward, 1985*b*, p. 54, Pl. 6, fig. 8.
Mercenaria gardnerae Kellum. Ward, 1985*c*, Pl. 6, fig. 8.
Mercenaria gardnerae Kellum. Ward, 1987, p. 133, Pl. 6, fig. 8.
Mercenaria gardnerae Kellum. Ward, 1989, p. 83, Pl. 6, fig. 8.
Mercenaria gardnerae Kellum. Ward and Powars, 1989, p. 31, Pl. 6, fig. 8.
Mercenaria gardnerae Kellum. Ward, *in* Johnson et al., 1990, Pl. 6, fig. 8.
Not—
Venus campechiensis capax Glenn, 1904, p. 308–309, Pl. LXXX, fig. 1; Pl. LXXXI, fig. 1.
Mercenaria campechiensis var. *capax* Vokes, 1957, p. 18, Pl. 14, fig. 3; Pl. 15, fig. 2.
Mercenaria gardnerae (Kellum). Carter et al., 1988, p. 80, Pl. 6, fig. 49.

Discussion.—*Mercenaria capax* was first described by Conrad (1843*b*) from fossil material obtained by Michael Tuomey along the Pamunkey River, in [New] Kent County, Va. Tuomey, later to become the state geologist of South Carolina, probably was collecting on the Pamunkey at the invitation of Edmund Ruffin, formerly state geologist of South Carolina, who owned considerable property there. Conrad (1845) repeated the description and figured M. *capax*. By its inclusion in a report on "Fossils of the Miocene Formation of the United States," Conrad implied its age was Miocene. Palmer (1927) figured the type material and stated the occurrence as "Upper Miocene" but gave no data to support the claim. Until Ward (1984) recognized the presence of the Old Church Formation (upper Oligocene and lower Miocene), no stratigraphic units were known in the area that could have been the source of M. *capax*. Ward (1984) first assigned the *Mercenaria* in the Old Church to M. *gardnerae*, recognizing that it was identical to that taxon as figured by Richards (1948, 1950). Later study showed that Richards' (1948, 1950) specimens, although identical with the Old Church form, were not M. *gardnerae* Kellum. *Mercenaria gardnerae* is a more elongate species, almost oval in outline. *Mercenaria capax* is a stouter form, almost circular in outline. Collections of the short, stout forms of *Mercenaria* from the Old Church Formation along the Pamunkey River in Hanover, New Kent, and King William Counties have made it certain that the taxon is M. *capax* and that it had been originally collected in that area. The specimens identified as *Venus campechiensis capax* by Glenn (1904) and Vokes (1957) are the young of M. *cuneata* Conrad.

Mercenaria capax is similar to M. *ducateli* (Conrad, 1838), which comes from the marl at Shiloh, New Jersey, now known as the Kirkwood Formation. The two species may be identical, and in that case the name M. *ducateli* would have priority. In any case, the specimen of *Venus ducateli* figured by Glenn (1904, Pl. LXXV, figs. 7, 8) from Church Hill, Md., appears to be identical to M. *capax* and may come from the same stratigraphic horizon.

Type information.—Type: Holotype ANSP 4131 cited by Palmer (1927), syntype figured by Palmer (1929, Pl. XXXIII, figs. 2, 4, 5). Moore (1962) cited

three syntypes labelled by Conrad at the ANSP. Richards (1968) listed a holotype and paratype of the number ANSP 4131. To avoid any confusion I herein designate the specimen figured by Palmer (1929) the lectotype. The specimen is a double valve. Type locality: "Pamunkey River, Kent Co., Virginia, Mr. Tuomey" (Conrad, 1843*b*, 1845).

Figured specimen.—Latex cast of a right valve (USNM 366541) from the Warren Brothers sand pit, Henrico County, Va. (locality 32).

Stratigraphic and geographic range.—Old Church Formation (upper Oligocene and lower Miocene) in Virginia; Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina. River Bend Formation (upper Oligocene) in North Carolina.

Family PETRICOLIDAE Deshayes, 1839
Genus *Pleiorytis* Conrad, 1863

Pleiorytis calvertensis (Dall, 1900)
Plate 17, figure 6

Petricola centenaria. Conrad, 1833, p. 341. [In part].
Petricola centenaria var. A, Conrad, 1838, p. 17.
Petricola (*Petricolaria*) *calvertensis* Dall, 1900, p. 1060–1061, Pl. 44, fig. 14.
Petricola (*Rupellaria*) *harrisii* Dall. Glenn, 1904, p. 302–303, Pl. LXXIII, figs. 8, 9. [Not *P. harrisii* of Dall, 1900].
Asaphis centenaria (Conrad). Glenn, 1904, p. 293, Pl. LXXI, figs. 8, 9.
Petricola (*Petricolaria*) *calvertensis* Dall. Glenn, 1904, p. 303, Pl. LXXIII, figs. 10–12.
Petricola harrisii Dall. Vokes, 1957, p. 19, Pl. 17, figs. 1, 2. [Not *P. harrisii* of Dall, 1900].
Petricola (*Petricolaria*) *calvertensis* Dall. Vokes, 1957, p. 19, Pl. 17, fig. 3.
Asaphis centenaria (Conrad). Vokes, 1957, p. 20–21, Pl. 18, figs. 4, 5.

Discussion.—*Pleiorytis harrisii* (Dall, 1900) was based on an injured, deformed specimen of *P. centenaria* Conrad (1833), which was found in the Yorktown Formation. Such specimens are not unusual within the genus. The specimen that Glenn (1904, Pl. LXXIII, figs. 8, 9) figured as *P. harrisii* is a similarly malformed *P. calvertensis* Dall. Conrad (1833) at first included the species from the Choptank Formation in *P. centenaria*, but later (Conrad, 1838) he recognized the difference in the two taxa and called the Choptank form *P. c.* var. A. The Choptank species was finally named *P. calvertensis* by Dall (1900). *Pleiorytis calvertensis* is smaller and proportionately more elongate than *P. centenaria*, has finer radial ribbing, and has more compressed valves.

The species is present in the Calvert and St. Marys Formations and is common in the Drumcliff Member of the Choptank.

Type information.—Holotype: USNM 145740. Type locality: "Miocene of Calvert Cliffs, Maryland" (Dall, 1900, p. 1060).

Figured specimen.—Right valve (USNM 405292) from Drumcliff on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Calvert, Choptank, and St. Marys Formations (lower middle Miocene to lower upper Miocene) in Maryland.

Order MYOIDA Stoliczka, 1870
Suborder MYINA Stoliczka, 1870
Superfamily MYOIDEA Lamarck, 1809
Family MYIDAE Lamarck, 1809
Genus *Mya* Linné, 1758

Mya wilsoni, new species
Plate 25, figures 10–12

Diagnosis.—Shell small, thick, and very truncate for the genus, irregular in outline and exterior sculpture.

Description.—Shell slightly inequivalved, the left valve being slightly more convex than the right. Left valve usually thicker than the right. Valves ovate to sub-circular; beaks central to posterior, depending upon the degree of truncation of the posterior margins. Both valves with low umbones and irregular, sometimes discontinuous, concentric, low, smooth undulations. Undulations easily discernible in early stages, but becoming irregular and difficult to follow in adults. Exterior of valves with growth anomalies and discontinuities, probably caused by predation. Margins smooth to irregular.

Left valve relatively deep, with strong hinge plate and large chondrophore. Subumbonal excavation produced as in *Mya* (*Mya*). Anterior leg moderately incised, anterior ridge strong distally, obsolete proximally. Fibrum receptacle smooth with a few obsolete concentric growth rings. Ventral margin arcuate and inclined posteriorly. Laminum attachment narrow and deeply incised. Posterior ridge strong and widening distally. Posterior furrow narrow and very deeply incised. Posterior muscle scar in left valve very deep. Pallial line entire and running anteriorly, ventrally, and posteriorly to produce a large pallial sinus two-

thirds of the length of the shell. Posterior muscle scar circular, anterior muscle scar lunate.

Right valve slightly thinner and less convex than the left valve. Exterior sculpture and margins same as left valve. Large V-shaped receptacle under the beak designed to accommodate the chondrophore of the left valve. Posterior and anterior muscle scars as in left valve.

Measurements (in millimeters).—Asterisk (*) indicates broken specimen and no measurement.

Measured specimen	valve	height	length	width
Holotype (USNM 338603)	LV	20.7	27.8	7.9
Paratype (USNM 338604)	LV	20.3	*	7.6
Paratype (USNM 338605)	LV	*	*	*
Paratype (USNM 338606)	LV	*	29.0	8.9
Paratype (USNM 338607)	RV	*	*	*
Paratype (USNM 338608)	LV	27.7	31.4	10.8
Paratype (USNM 338609)	RV	23.1	30.7	17.4
Paratype (USNM 338610)	LV	20.5	*	7.6
Paratype (USNM 338611)	RV	*	*	*
Paratype (USNM 338612)	RV	*	*	*
Paratype (USNM 338613)	RV	18.9	*	*
Paratype (USNM 338614)	RV	*	*	*
Paratype (USNM 338615)	RV	29.0	37.0	7.9
Paratype (USNM 338616)	LV	*	*	11.0
Paratype (USNM 338617)	RV	24.2	33.0	17.0
Paratype (USNM 338618)	LV	20.6	*	*
Paratype (USNM 338619)	LV	22.5	29.5	6.2

Discussion.—This species is very irregular in form; some of its deformities may be pathologic, the result of predation, or due to its nestling habit. It is distinct from any of the taxa treated by MacNeil (1965) in his mongraph on the genus *Mya* and was mentioned briefly by him in a note (p. 13). It has the overall shape of his *Mya truncata* Group and the chondrophore structure of *Mya* (*Mya*). The description of the chondrophore incorporates the terminology of MacNeil (1965, p. 22).

The species is common at the quarry at Belgrade, N.C. and is usually found fragmented, having been deposited in a near-beach environment. Of the author's twenty-eight specimens, nine are complete or nearly complete valves.

Etymology.—*Mya wilsoni* is named in honor of Druid Wilson of the National Museum of Natural History, who first pointed out the existance of the taxon to MacNeil (1965, p. 13). The information was received too late to permit taxonomic treatment in MacNeil's (1965) monograph on *Mya*.

Type information.—Holotype: USNM 338603. Type locality: Martin Marietta Company Quarry, Belgrade, Onslow County, N.C., in the Haywood Landing Member of the Belgrade Formation (locality 29).

Figured specimen.—Holotype (USNM 338603).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Family CORBULIDAE Lamarck, 1818
Subfamily CORBULINAE Gray, 1823
Genus *Bicorbula* Fischer, 1887

Bicorbula idonea (Conrad, 1833)
Plate 21, figure 1

Corbula idonea Conrad, 1833, p. 341.
Corbula idonea Conrad. Conrad, 1838, p. 6–7, Pl. X, fig. 6.
Corbula idonea Conrad. Whitfield, 1894, p. 88, Pl. XV, fig. 20.
Corbula (*Corbula*) *idonea* Conrad. Dall, 1898*b*, p. 852.
Corbula idonea Conrad. Glenn, 1904, p. 279–280, Pl. LXVII, figs. 1–3.
Corbula idonea Conrad. Schoonover 1941, p. 230–231, Pl. 12, figs. 10–14.
Corbula idonea Conrad. Richards and Harbison, 1942, p. 198, Pl. 15, figs. 7, 15.
Corbula idonea Conrad. Richards, 1943, p. 522, Pl. 84, figs. 13, 14.
Corbula (*Bicorbula*) *idonea* Conrad. Vokes, 1957, p. 23, Pl. 19, figs. 5–7.
Corbula (*Caryocorbula*) *drumcliffensis* Oleksyshyn, 1960, p. 105–106, figs. 7, 8.
Bicorbula idonea (Conrad). Ward, 1984, Pl. 7, fig. 2.
Bicorbula idonea (Conrad). Ward, 1985*b*, Pl. 7, fig. 2.
Bicorbula idonea (Conrad). Ward, 1985*c*, Pl. 7, fig. 2.
Bicorbula idonea (Conrad). Ward, 1987, p. 134, Pl. 7, fig. 2.
Bicorbula idonea (Conrad). Ward, 1989, p. 84, Pl. 7, fig. 2.
Bicorbula idonea (Conrad). Ward and Powars, 1989, p. 33, Pl. 7, fig. 2.
Bicorbula idonea (Conrad). Ward, *in* Johnson et al., 1990, Pl. 7, fig. 2.

Discussion.—*Bicorbula idonea* (Conrad, 1833) is the largest of the corbulid taxa in the Miocene beds of the middle Atlantic, and it is well-represented there in the upper Oligocene to the middle middle Miocene. Above the Choptank Formation the species rarely occurs but is known from the St. Marys and Eastover Formations. The specimen named *Corbula drumcliffensis* by Oleksyshyn (1960) is a juvenile of *Bicorbula idonea* (Conrad).

Type information.—Moore (1962) cited the type specimens as missing. Richards (1968) reported that a possible type lot is present in the Academy of Natural Sciences of Philadelphia but gave no catalog number. This author did not see the specimens among Conrad's types at the Academy of Natural

Sciences of Philadelphia. Type locality: "Choptank River near Easton, Md., common" (Conrad, 1833, p. 341).

Figured specimen.—Right valve (USNM 380694) from Camp Roosevelt on the western shore of the Chesapeake Bay, Calvert County, Md.; from Bed 10 of the Plum Point Marl Member of the Calvert Formation.

Stratigraphic and geographic range.—Belgrade Formation in North Carolina, Edisto Formation in South Carolina, and Old Church Formation in Virginia (all upper Oligocene and lower Miocene). Calvert and Choptank Formations (lower middle to upper middle Miocene) in Maryland and Virginia. St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland. Eastover Formation, Claremont Manor Member (upper Miocene) in Virginia.

Genus *Varicorbula* Grant and Gale, 1931

Varicorbula elevata (Conrad, 1838)
Plate 21, figure 2

Corbula elevata Conrad, 1838, p. 7, Pl. IV, fig. 3.
Corbula curta Conrad, 1868, p. 269, Pl. XXI, figs. 6–8.
Corbula elevata Conrad. Whitfield, 1894, p. 86–87, Pl. XV, figs. 15–19.
Corbula (Aloidis) elevata Conrad. Dall, 1898*b*, p. 852.
Corbula elevata Conrad. Glenn, 1904, p. 280, Pl. LXVII, figs. 4, 5.
Corbula elevata Conrad. Schoonover, 1941, p. 231–232, Pl. 12, figs. 4–9.
Corbula elevata Conrad. Richards and Harbison, 1942, p. 198, Pl. 15, figs. 9, 10.
Corbula (Varicorbula) elevata Conrad. Vokes, 1957, p. 22, Pl. 19, figs. 11, 12.

Discussion.—*Varicorbula elevata* (Conrad) is extremely abundant in Beds 4–9 in the Plum Point Marl Member, almost to the exclusion of other taxa. It is less abundant but common in Bed 10 of the same member and is not known above that bed.

Type information.—Richards (1968) reports a possible type lot of "*Corbula*" *elevata* at the Academy of Natural Sciences of Philadelphia (ANSP 14095). The present author did not see the specimens among Conrad's type material. Type locality: "Stow Creek, Cumberland County, New Jersey" (Conrad, 1838, p. 7).

Figured specimen.—Right valve (USNM 405293) from Camp Roosevelt on the western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Beds 4–10 in Maryland (lower and lower middle Miocene).

Superfamily HIATELLOIDEA Gray, 1824
Family HIATELLIDAE Gray, 1824
Genus *Panopea* Menard, 1807

Panopea goldfussii Wagner, 1839
Plate 4, figure 2; Plate 6, figure 3;
Plate 12, figure 4; Plate 16, figure 3

Panopea goldfussii Wagner, 1839, p. 52, Pl. 1, fig. 3.
Panopaea porrecta Conrad, 1845, p. 71–72, Pl. 41, fig. 2.
Glycimeris porrecta Conrad. Conrad, 1863*b*, p. 572.
Glycimeris goldfussii Wagner. Conrad, 1863*b*, p. 571.
Panopea goldfussii Wagner. Dall, 1898*b*, p. 829.
Panopea goldfussii Wagner. Glenn, 1904, p. 277, Pl. LXVI, fig. 1.
Panope goldfussii (Wagner). Mansfield, 1932, p. 162–164, Pl. 33, figs. 8, 9.
Panope goldfussii Wagner. Vokes, 1957, p. 23, Pl. 20, fig. 3.
Panope goldfussii Wagner. Ward, 1984, Pl. 8, fig. 3.
Panope goldfussii Wagner. Ward, 1985*b*, Pl. 8, fig. 3.
Panope goldfussii Wagner. Ward, 1985*c*, Pl. 8, fig. 3.
Panope goldfussii Wagner. Ward, 1987, p. 135, Pl. 8, fig. 3.
Panope goldfussii Wagner. Ward, 1989, p. 85, Pl. 8, fig. 3.
Panope goldfussii Wagner. Ward and Powars, 1989, p. 38, Pl. 8, fig. 3; Pl. 12, fig. 3.
Panope goldfussii Wagner. Ward, *in* Johnson et al., 1990, Pl. 8, fig. 3.

Discussion.—*Panopea goldfussii* is common in the molluscan assemblages of the Calvert, Choptank, St. Marys, and Eastover Formations. It is also common in the Yorktown Formation, and there is a questionable occurrence of the taxon in the James City Formation (lower Pleistocene) in North Carolina. It is not known in younger beds. In the Calvert and Choptank, *P. goldfussii* co-occurs with *Panopea americana* Conrad, 1838, and in the Yorktown it co-occurs with *Panopea reflexa* Say, 1824. It is different from both of those taxa in being much thinner-valved and smaller and in tapering posteriorly. Apparently because of its deep burrowing habits, the valves are usually found together, upright, in its living position.

Type information.—The whereabouts of the type is unknown but may be the Wagner Free Institute of Science of Philadelphia. If the type cannot be located, I herein designate the figured specimen (USNM 405296; Pl. 16, fig. 3) from Drumcliff, Patuxent River, St. Marys County, Md., as neotype. Type locality: Wagner (1939) named *Pecten marylandicus*,

Panopea goldfussii, and *Mysia nucleiformis* in the same paper and gave the "Meherin River" [Meherrin River, N.C.] as the locality. These taxa probably came from St. Marys County, Md., in the Choptank Formation on the Patuxent River, as did another species, *Trochus eboreus*, he named in the same paper. That taxon was said to have come from the "Banks of the Patuxent River, Maryland" (Wagner, 1839, p. 53). *Panopea goldfussii* Wagner does occur sparingly in the Yorktown Formation of Murfreesboro, N.C., but Wagner's figured specimen and the other associated taxa described by Wagner are most likely to have occurred together at Drumcliff in Maryland. For this reason I have selected as neotype a specimen (USNM 405296) from the section that I believe is the type locality. Conrad's (1845) species *P. porrecta* also came from this locality.

Figured specimens.—Plate 4, figure 2: Right valve (USNM 405294) from 2.7 km below Bowlers Wharf, Essex County, Va. (locality 2). Plate 6, figure 3: Right valve (USNM 380703) from just above the mouth of Sunken Meadow Creek, right bank of the James River, Surry County, Va. (USGS locality 26041). Plate 12, figure 4: Left valve (USNM 405295) from below Little Cove Point, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15). Plate 16, figure 3: Neotype, a right valve (USNM 405296) from Drumcliff (Jones Wharf) on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Calvert Formation (lower middle Miocene) in Maryland and Virginia; Choptank Formation (middle middle Miocene) in Maryland and Virginia; St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland and Windmill Point beds (lower upper Miocene) in Maryland and Virginia. Eastover Formation (upper Miocene) in Virginia. Yorktown Formation (upper Pliocene) in Virginia, North Carolina, and South Carolina.

Panopea whitfieldi Dall, 1898
Plate 21, figure 4

Panopaea goldfussii Wagner. Whitfield, 1894, p. 89–90, Pl. XVI, figs. 9–13. [Not *P. goldfussii* of Wagner, 1839].
Panopea whitfieldi Dall, 1898*b*, p. 829.
Panopea whitfieldi Dall. Glenn, 1904, p. 276–277, Pl. LXV, fig. 10.
Panope whitfieldi Dall. Dall, 1915, p. 156, Pl. 18, figs. 1, 2.
Panopea whitfieldi Dall. Richards and Harbison, 1942, p. 201, Pl. 14, figs. 1, 7, 8.
Panope whitfieldi Dall. Vokes, 1957, p. 23, Pl. 20, fig. 2.
Panope sp. Kellum, 1926, p. 39, Pl. X, figs. 5–7.
Panope parawhitfieldi Gardner, 1928, p. 237–238, Pl. XXXVI, figs. 11–12.
Panope sp. indet. Gardner, 1928, p. 238.
Panope sp. Richards and Hopkins, 1960, p. 23, Pl. 1, fig. 9.

Discussion.—*Panopea whitfieldi* Dall is present but not common in the lower Calvert Formation, and its highest known occurrence is Bed 10 of the Plum Point Marl Member. It differs from *Panopea goldfussii* in being more equilateral, more rounded posteriorly, and much less produced posteriorly. Gardner's (1928) species *P. parawhitfieldi* is considered to be well within the size range of *P. whitfieldi* and is here synonomized with that taxon.

Type information.—The species was based on Whitfield's (1894, Pl. XVI, figs. 9–13) figures of specimens from Jericho, New Jersey, that were in the National Museum of Natural History. The specimen is now in the Dall collection (USNM 111584). Type locality: Jericho, N.J.

Figured specimen.—Right valve (USNM 405297) from Camp Roosevelt, on the west bank of the Chesapeake Bay, Calvert County, Md., in Bed 10 of the Plum Point Marl Member.

Stratigraphic and geographic range.—Tampa Formation (upper Oligocene and lower Miocene) in southern Florida. Edisto Formation (upper Oligocene and lower Miocene) in South Carolina. Calvert Formation, Fairhaven Member and Bed 10 of the Plum Point Marl Member (lower middle Miocene) in Maryland.

Panopea americana Conrad, 1838
Plate 16, figure 5

Panopaea americana Conrad, 1838, p. 4, Pl. II.
Glycimeris americana Conrad. Conrad, 1863*b*, p. 571.
Panopea americana Conrad. Dall, 1898*b*, p. 830.
Panopea americana Conrad. Glenn, 1904, p. 278, Pl. LXVI, fig. 2.
Panopea americana Conrad. Berry, 1936, p. 469, figs. 1–3.
Panope americana Conrad. Vokes, 1957, p. 23, Pl. 20, fig. 1.
Panopea americana Conrad. Ward and Powars, 1989, p. 34, Pl. 8, fig. 5.

Discussion.—*Panopea americana* Conrad is distinguished by its large size, thick valves, and posterior and anterior gape. It is present in Bed 10 of the Plum Point Marl Member of the Calvert Formation, abundant in the Drumcliff Member (Bed 17), and common in the Boston Cliffs Member (Bed 19) of the

Choptank Formation. It is not known to occur in beds above the Choptank. It usually occurs with both valves adhering, upright, in living position.

Type information.—Moore (1962) listed syntypes for *P. americana* that were labelled by Conrad, which agreed with his measurements, but not with his figures. Richards (1968) reported the type in the collections of the Academy of Natural Sciences of Philadelphia (ANSP 16376). Type locality: "Patuxent River, Maryland" (Conrad, 1838) [probably Drumcliff, St. Marys County, Md., in Bed 17 (Drumcliff Member)].

Figured specimen.—Right valve (USNM 405298) from Drumcliff (Jones Wharf) on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland; Choptank Formation (middle middle and upper middle Miocene) in Maryland and Virginia.

Suborder PHOLADINA H. Adams and A. Adams, 1858
Superfamily PHOLADOIDEA Lamarck, 1809
Family TEREDINIDAE Rafinesque, 1815
Subfamily KUPHINAE Tryon, 1862
Genus *Kuphus* Guettard, 1770

Kuphus fistula (H. C. Lea, 1843)
Plate 4, figure 1

Teredo fistula H. C. Lea, 1843*a*, p. 163. [name only].
Teredo fistula H. C. Lea, 1843*b*, [descriptions in Latin only, no fig.].
Teredo fistula H. C. Lea. Lea, H. C., 1845, p. 234, Pl. 34, fig. 5.
Teredo fistula H. C. Lea. Conrad, 1845, p. 77, Pl. XLIV, fig. 3.
Teredina fistula (H. C. Lea). Johnson, 1904, p. 13–14, figs. 1, 2.
Teredo fistula Lea. Richards, 1950, p. 80, fig. 73 c.
Kuphus calamus (H. C. Lea). Gardner, 1943 [1944], p. 143–144, Pl. 23, fig. 35. [Not *Teredo calamus* H. C. Lea, 1843].

Discussion.—Gardner (1943 [1944]) believed that *Teredo calamus* H. C. Lea and *T. fistula* H. C. Lea were the same species and used the name *Kuphus calamus* because of its priority of first appearance in the same publication: *T. calamus* (fig. 4 of Lea, 1845), *T. fistula* (fig. 5 of Lea 1845). The two taxa have different growth forms and habitats. Lea (1845, p. 234) stated that his *T. calamus* was found by breaking open a piece of coral. The form he called *T. fistula* lives in solitary tapering tubes in sand, is not attached to other objects, and does not occur within borings into hard substrates. *Teredo calamus* probably properly belongs within that genus *Teredo*. *T. fistula* belongs within the genus *Kuphus*.

Kuphus fistula (H. C. Lea) is present but never abundant in the Cobham Bay Member of the Eastover Formation. It is very abundant in the Sunken Meadow Member of the Yorktown Formation and is common in the Rushmere and Moore House Members of that formation.

Type information.—Gardner (1943 [1944]) stated that she studied the types of *Teredo fistula*, but Richards (1968) listed only *Teredo calamus* as being present in the H. C. Lea collection at the Academy of Natural Sciences of Philadelphia. I suggest the use of Gardner's (1943 [1944]) figured specimen (Pl. 23, fig. 35) as neotype. It is not a topotype but probably comes from the same unit (Yorktown Formation, Rushmere Member), not far from Petersburg, at Baileys Creek, James River, Prince George County, Va. Type locality: "Tertiary of Petersburg, Virginia" (H. C. Lea, 1845).

Figured specimen.—Incomplete specimen (USNM 405299) from 2.7 km below Bowlers Wharf, Essex County, Va. (locality 2).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia. Yorktown Formation (lower and upper (Pliocene) in Virginia, North Carolina, and South Carolina. Raysor Formation (upper Pliocene) in South Carolina.

Class GASTROPODA Cuvier, 1797
Subclass PROSOBRANCHIA Milne Edwards, 1848
Order CAENOGASTROPODA Cox, 1959
Superfamily CERITHIOIDEA Fleming, 1822
Family TURRITELLIDAE Clarke, 1851
Genus *Turritella* Lamarck, 1799

Turritella plebeia plebeia Say, 1824
Plate 4, figure 3; Plate 8, figure 5

Turritella plebeia Say, 1824, p. 125, Pl. VII, fig. 1.
Turritella octonaria Conrad, 1834, p. 144.
Turritella plebeia Say. Conrad, 1863*b*, p. 568.
Turritella octonaria Conrad. Conrad, 1863*b*, p. 568.
Turritella plebeia Say. Martin, 1904, p. 234–236, Pl. LVI, figs. 4, 5, 7.
Turritella plebeia Say. Richards and Harbison, 1942, p. 204, Pl.

18, figs. 4, 9.
Turritella plebeia Say. Vokes, 1957, p. 27, Pl. 22, figs. 6, 8.
Mariacolpus plebeia (Say). Petuch, 1988c, p. 42, Pl. 7, figs. 10, 11.
Turritella plebeia Say. Ward and Powars, 1989, p. 36, Pl. 10, fig. 5.

Discussion.—*Turritella plebeia* Say is variable in form and occurs in the Calvert, Choptank, St. Marys, and Eastover Formations. It is extremely abundant in the last three units and occurs in greatest numbers in the finer, siltier sediments. In many beds the taxon is concentrated in great numbers along thin bedding planes and in pockets. The specimens commonly are water worn and are current aligned.

Type information.—Say's types from the Finch collection were sent to England and now are in the British Museum (Natural History). Newton (1902) listed *T. plebia* as missing. Say's illustrated specimen (1824, Pl. VII, fig. 1), although broken, is adequate to be sure of its identity in the Miocene beds. The figure of the type looks most like specimens in the Cobham Bay Member of the Eastover Formation in the vicinity of Cobham Wharf, Surry County, Va. The type probably came from beds now known as the Eastover Formation, upriver of Yorktown on the York River, Va. I herein designate the figured specimen (Pl. 3, fig. 4) as neotype (USNM 405300). Type locality: Said to be "Maryland" but probably the bluffs along the York River near Yorktown, Va. See discussion on *Rasia arata* (Say, 1824).

Figured specimen.—Plate 3, figure 4: Neotype (USNM 405300) from 2.7 km below Bowlers Wharf, Essex County, Va. (locality 2). Plate 8, figure 5: Specimen (USNM 405301) from above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12).

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl and Calvert Beach Members (lower middle Miocene) in Maryland. Choptank Formation (middle middle and upper middle Miocene) in Maryland and Virginia. St. Marys Formation (lower upper Miocene) in Maryland and Virginia. Eastover Formation (upper Miocene) in Virginia and North Carolina.

Turritella plebeia carinata Gardner, 1948
Plate 6, figure 9

Turritella plebeia carinata Gardner, 1948*b*, p. 196–197, Pl. 27, fig. 15. [Not fig. 22].
Turritella sp. aff. *T. plebeia* (Say, 1824). Ward and Blackwelder, 1980, Pl. 1, fig. 11.
Turritella plebeia ssp. Ward, 1984, p. 63, Pl. 9, fig. 11.
Turritella plebeia ssp. Ward, 1985*b*, p. 63, Pl. 9, fig. 11.
Turritella plebeia ssp. Ward, 1985c, Pl. 9, fig. 11.
Turritella plebeia ssp. Ward, 1987, p. 136, Pl. 9, fig. 1.
Turritella plebeia ssp. Ward, 1989, p. 86, Pl. 9, fig. 11.
Turritella plebeia ssp. Ward and Powars, 1989, p. 39, Pl. 13, fig. 1.
Turritella plebeia ssp. Ward, *in* Johnson et al., 1990, Pl. 9, fig. 11.

Discussion.—This subspecies may represent a geographic variation of *T. plebeia* Say, but it is a readily identifiable form. It differs from *T. plebeia* Say in having several, much stronger spiral threads that form an angular shoulder. Gardner's (1948, p. 197, Pl. 27, fig. 22) identification of the subspecies in the Yorktown Formation is doubtful, being based on a single specimen which supposedly came from Suffolk, Va. The subspecies is common in the Claremont Manor Member of the Eastover Formation, and to this author's knowledge it is limited to that unit.

Type information.—Holotype: USNM 325453. Type locality: "One fourth of a mile below Jones Point, Essex County. St. Marys formation" (Gardner, 1948*b*, p. 197) [from the Claremont Manor Member, Eastover Formation].

Figured specimen.—Specimen (USNM 258357) from just below the mouth of Upper Chippokes Creek on the James River, Surry County, Va. (USGS locality 26042).

Stratigraphic and geographic range.—Eastover Formation, Claremont Manor Member (upper Miocene) in Virginia.

Turritella subvariabilis subvariabilis d'Orbigny, 1852
Plate 8, figure 4

Turritella variabilis Conrad, 1830, p. 221, Pl. X, fig. 3. [Not *Turritella variabilis* DeFrance, 1828].
Turritella subvariabilis d'Orbigny, 1852, vol. 3, p. 32, no. 448.
Turritella variabilis Conrad. Conrad, 1863*b*, p. 568.
Turritella variabilis Conrad. Martin, 1904, p. 236 [In part, Pl. LVII, fig. 1].
Turritella sp. cf. *T. variabilis* Conrad. Gardner, 1948*a*, p. 116, Pl. 1, fig. 22.
Turritella variabilis Conrad. Vokes, 1957, p. 26, Pl. 22, fig. 2.
Turritella subvariabilis d'Orbigny. Ward and Powars, 1989, p. 36, Pl. 10, fig. 4.

Discussion.—Conrad's (1830) name for the taxon from the St. Marys River was preoccupied (*T. variabilis* Defrance), as pointed out by d'Orbigny (1852),

who renamed the species *T. subvariabilis* based on Conrad's description and figure. The name *T. variabilis* has long been loosely applied to Atlantic Coastal Plain turritellids with flat whorls and several spiral threads. *T. subvariabilis, sensu stricto* is found only in the Windmill Point beds of the St. Marys Formation.

Type information.—Moore (1962) and Richards (1968) did not cite *Turritella variabilis* Conrad among Conrad's types at the Academy of Natural Sciences of Philadelphia. I designate the specimen figured here of *Turritella subvariabilis* d'Orbigny, 1852 (Pl. 8, fig. 4), a topotype, the neotype. The neotype is in the National Museum of Natural History (USNM 405302) and measures 72.2 mm in height. The last whorl is 12 mm wide.

Figured specimen.—Neotype (USNM 405302), from above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland and Virginia.

Turritella subvariabilis bohaskai new subspecies
Plate 13, figures 4, 5

Diagnosis.—Shell small, elevated, multispiral, flat-sided, and very gradually tapering.

Description.—Shell small, very high for its size, multispiral, very gradually tapering. Whorls small, flat-sided, with changing spiral threading. Spiral sculpture consisting of three low, thin striae below and a very faint fourth striae above. Suture between whorls very shallowly impressed in early whorls, becoming somewhat indented in later whorls. Details of the protoconch unavailable as no individuals preserve this portion of the shell. Aperture broken in the type material and in most specimens but can be determined to be holostomatous and subovate to slightly angular near the suture. Parietal wall delineated, somewhat glazed, columella lacking umbilicus.

Measurements.—Holotype (USNM 405303): Height 39.1 mm.; width of the body whorl 8.2 mm (incomplete specimen). Paratype (USNM 405304): Height 29.4 mm.; width of the body whorl 5.7 mm (incomplete specimen).

Discussion.—*Turritella subvariabilis bohaskai*, new subspecies, is closely related to *T. subvariabilis subvariabilis*, differing principally in the much narrower spiral angle. The taxon is common in the shell beds of the Little Cove Point beds of the St. Marys Formation in the vicinity of Little Cove Point, Calvert County, Md. The subspecies is named in honor of Dave Bohaska of the Calvert County Marine Museum, who has volunteered much of his time in helping the author in his work.

Type information.—Holotype: USNM 405303. Paratype: USNM 405304. Type locality: Below Little Cove Point, western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Figured specimen.—Plate 13, figure 4: Holotype (USNM 405303) from below Little Cove Point, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15). Plate 13, figure 5: Paratype (USNM 405304) from the same locality.

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland.

Turritella subvariabilis dianae new subspecies
Plate 19, figure 8

Turritella sp. Ward and Powars, 1989, p. 35, Pl. 9, fig. 8.

Diagnosis.—Shell very small, thin, multispiral, sharply tapering, with four primary spiral ribs and numerous secondaries on the last whorl.

Description.—Shell very small, about 14 whorls, with an acute spiral angle. Whorls flat-sided with narrowly incised sutures becoming more impressed in the later stages. Spiral ornamentation consists of four primary ribs. The lowest rib is developed along the angulation between the lower part of the whorl and the suture. Lowest rib weak in early stages, becoming increasingly prominent. Lower middle rib strongest in all stages. Upper middle rib and upper rib nearly equal in size. In adult stages the upper body whorl is angled from the upper spiral rib to the suture, creating a shoulder. Two fine spiral threads are developed between the upper rib and the upper middle rib, and two small threads are developed between the upper middle rib and the lower middle rib.

Measurements of the holotype (USNM 405306): Height 21.4 mm, width of last whorl 5.0 mm.

Discussion.—As in other subspecies of *Turritella subvariabilis* d'Orbigny, this taxon superficially resembles the others. The differences in *T. s. dianae*, n. subsp. and other taxa are discussed in the section on *Turritella terebriformis* (below). *Turritella s. dianae* is remarkable for its very small size, and it is extremely abundant in the Drumcliff Member (Bed 17) of the

Choptank Formation. It has a wider spiral angle than the later *T. terebriformis* and has substantially different spiral ribbing from that taxon or the earlier *T. exaltata* Conrad.

Turritella subvariabilis dianae is named in honor of Diane Blackwelder.

Type information.—Holotype: USNM 405306. Type locality: Drumcliff, Patuxent River, St. Marys County, Md. (locality 16) in the Drumcliff Member (Bed 17).

Figured specimen.—Holotype (USNM 405306).

Stratigraphic and geographic range.—Choptank Formation, Drumcliff Member (middle middle Miocene) in Maryland.

Turritella terebriformis Dall, 1892
Plate 15, figure 5

Turritella terebriformis Conrad, 1863*b*, p. 568. [Name in list only].
Turritella terebriformis Dall, 1892, p. 311–312.
Turritella terebriformis Dall, 1903, p. 1653. [Locality data corrected in errata].
Turritella variabilis var. *alticostata* Conrad. Martin, 1904, p. 237, Pl. LVII, fig. 2. [Not *T. alticostata* of Conrad, 1834].
Turritella variabilis var. *cumberlandia* Conrad. Martin, 1904, p. 237–238. [In part].
Turritella (*Torcula*) *terebriformis* Dall. Gardner, 1948*b*, p. 199, Pl. 27, figs. 26, 27.

Discussion.—In size, *Turritella terebriformis* Dall equals *Turritella pilsbryi* Gardner, 1928 from the Sunken Meadow Member of the Yorktown Formation. It differs from that taxon in having a smaller spiral angle and in having different spiral ornamentation. *Turritella subvariabilis bohaskai*, new subspecies, has a narrower spiral angle than *T. terebriformis* and has three spiral ribs instead of two in the middle of the body whorl. *Turritella s. bohaskai* is also much smaller, and its sutures are much less impressed. *Turritella terebriformis* differs from *T. s. dianae*, which is abundant in the Drumcliff Member of the Choptank Formation, by being much larger, having a smaller spiral angle, and having different spiral ribbing. The last whorl of the figured specimen of *T. terebriformis* (USNM 405305) is 21.4 mm wide. The last whorl of the holotype of *T. s. dianae* n. subsp. (USNM 405306) is 5.0 mm. On *T. subvariabilis* d'Orbigny the upper rib on the body whorl is largest, while in *T. v. moranae* the reverse is true.

Type information.—Type: Dall (1892, p. 311) stated that Harris found Conrad's type of *Turritella terebriformis* at the Academy of Natural Sciences of Philadelphia. Richards (1968) did not list *T. terebriformis* from among the types at ANSP. I herein designate Gardner's figured specimen (1948*b*, Pl. 27, fig. 27, USNM 113479), a topotype, as the neotype. Type locality: "Greenboro [*sic*], Maryland" (Dall, 1903, p. 1653).

Figured specimen.—USNM 405305 from below Flag Pond, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 17).

Stratigraphic and geographic range.—Choptank Formation, Boston Cliffs Member (Bed 19) (upper middle Miocene) in Maryland and Virginia.

Turritella exaltata Conrad, 1841
Plate 23, figures 6, 9

Turritella exaltata Conrad, 1841, p. 32.
Turritella exaltata Conrad. Conrad, 1842*a*, p. 188–189.
Turritella exaltata Conrad. Conrad, 1863*b*, p. 567.
Turritella variabilis var. *exaltata* Conrad. Martin, 1904, p. 238, p. LVII, fig. 5.
Turritella variabilis var. *cumberlandia* Conrad. Martin, 1904, p. 237–238, Pl. LVII, fig. 4. [In part].
Turritella variabilis var. *cumberlandia* Conrad. Vokes, 1957, p. 26, Pl. 22, fig. 3. [In part].

Discussion.—*Turritella exaltata* Conrad, 1841 is a very high-spired form that is variable in its spiral ornamentation. Martin (1904) assigned all the forms of *Turritella* within the Calvert and Choptank Formations having a single prominent spiral rib to "*T. variabilis* var. *exaltata*" and all the forms in those units with two prominent spiral ribs to "*T. v.* var. *cumberlandia*." Examination of a number of topotype specimens of *T. cumberlandia* in the National Museum of Natural History from Shiloh, Cumberland County, N.J. (USGS locality 2106), revealed several important differences in the forms from the Calvert Formation in Maryland and those from the Kirkwood Formation in New Jersey. *Turritella cumberlandia* from the type area are much smaller in average size and have a wider spiral angle than any specimens of *Turritella* in the Calvert. One form, illustrated by Martin (1904, Pl. LVII, fig. 3), has almost the same spiral ornamentation as *T. cumberlandia*, but it is much higher spired and lacks the very pronounced impressed sutures of that taxon. The form, illustrated by Martin (fig. 3), may be a variety of *T. exaltata* or may be a separate species. *Turritella exaltata* is common in Bed 10 of the Plum Point Marl Member of the Calvert Formation in Maryland.

Type information.—Richards (1968) reported that the types of *Turritella exaltata* Conrad were in the

Academy of Natural Sciences of Philadelphia (ANSP 15523). Type locality: "...in the Medial Tertiary deposits of Calvert Cliffs, Maryland" (Conrad, 1841, p. 28).

Figured specimen.—Plate 23, figure 6: Specimen (USNM 405307) from Plum Point, on the western shore of the Chesapeake Bay, Calvert County, Md. Plate 23, figure 9: Specimen (USNM 405308) from the same locality.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland.

Turritella indenta Conrad, 1841
Plate 23, figure 10.

Turritella indenta Conrad, 1841, p. 32.
Turritella indenta Conrad. Conrad, 1842*a*, p. 188.
Turritella indenta Conrad. Conrad, 1868, p. 258, Pl. 21, fig. 13.
Turritella indenta Conrad. Dall, 1892, p. 308. [In part].
Turritella indenta Conrad. Burns, 1899, p. 68–69.
Turritella indenta Conrad. Martin, 1904, p. 233–234, Pl. LVI, figs. 1, 2.
Turritella indentata Conrad. Vokes, 1957, p. 27, Pl. 22, fig. 1.
Turritella calvertensis Oleksyshyn, 1959, p. 30, Pl. 4, fig. 1.
Turritella calvertensis marylandica Oleksyshyn, 1959, p. 30, Pl. 4, fig. 2.
Turritella calvertensis plumpointensis Oleksyshyn, 1959, p. 30–31, Pl. 4, fig. 3.
Turritella indenta chesapeakensis Oleksyshyn, 1959, p. 31, Pl. 4, fig. 4.
Calvertitella indenta (Conrad). Petuch, 1988*d*, Pl. 1, fig. 3.
Calvertitella pagodula Petuch, 1988*d*, p. 70–71, Pl. 1, figs. 1–2.

Discussion.—The taxa described by Conrad (1841) with *Turritella indenta* make it clear that most of the collection and specifically that species came from the unit now known as Bed 10 of the Plum Point Marl Member of the Calvert Formation. The stout form, indented suture, and spiral sculpture suggest that *T. indenta* is related to its precursor *T. tampae* Heilprin, 1886 (Pl. 26, fig. 3). If this relationship is correct, *Turritella indenta* is the last species, known to the author, of a lineage that may have had its beginning with *T. mortoni* Conrad, 1830, in the Paleocene. Dr. Warren D. Allmon (University of South Florida, Tampa, Fla.) believes that this similarity of forms is due to convergence and that *T. indenta* and *T. tampae* may have evolved from separate lineages (personal commum., 1990). *Turritella indenta* exhibits a fair amount of variation of form within any population, as do other taxa within that lineage. The taxa described by Oleksyshyn (1959) are believed to be only morphologic variations of *T. indenta*.

Type information.—The type of *Turritella indenta* was not reported by Richards (1968) among Conrad's types in the Academy of Natural Sciences of Philadelphia. I herein designate the figured specimen (USNM 405309), a topotype, the neotype. Type locality: "Medial Tertiary deposits of Calvert Cliffs, Maryland" (Conrad, 1841, p. 28). Measurements of the neotype: 57.2 mm in height, 17.6 mm in width.

Figured specimen.—Neotype (USNM 405309) from Camp Roosevelt, on the western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland.

Turritella tampae Heilprin, 1886
Plate 26, figure 3

Turritella tampae Heilprin, 1886, p. 113.
Turritella tampae Heilprin. Heilprin, 1887, p. 113, fig. 53.
Turritella tampae Heilprin. Dall, 1892, p. 309, Pl. 17, fig. 8.
Turritella tampae Heilprin. Dall, 1915, p. 97, Pl. 14, fig. 1.
Turritella (*tampae* var.?) *medioconstricta* Dall, 1915, p. 98, Pl. 13, fig. 3.
Turritella tampae Heilprin. Dall, 1916, p. 517.
Turritella tampae Heilprin. Cooke and Mossom, 1929, Pl. 8, fig. 3.
Turritella tampae Heilprin. Mansfield, 1937, p. 161–162.
Turritella tampae medioconstricta Dall. Mansfield, 1937, p. 162–163.
Turritella tampae Heilprin. Cooke, 1945, p. 117, fig. 15-3.

Discussion.—*Turritella tampae* Heilprin is common in the Haywood Landing Member of the Belgrade Formation (upper Oligocene and lower Miocene). It is present in beds of the same age from North Carolina to Florida. *Turritella tampae* is thick-shelled and stout with a deeply impressed suture in the later whorls. It appears to be closely related to *T. indenta* Conrad and is believed to belong to the same lineage.

Type information.—The whereabouts of the type material is unknown. Some of the taxa named by Heilprin are in the Academy of Natural Sciences of Philadelphia, but *Turritella tampae* is not listed by Richards (1968) as being in those collections. I herein designate Dall's (1892, Pl. 17, fig. 8) (1915, Pl. 14, fig. 1, USNM 165119) specimen the neotype. Type locality: "Silex-bearing marl (Miocene) of Ballast Point, Hillsboro Bay" [Fla.] (Heilprin, 1886, p. 105). Length of the neotype: 75 mm.

Figured specimen. — Specimen (USNM 405310) from Silverdale, Onslow County, N.C. (locality 30).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina. Edisto Formation (upper Oligocene and lower Miocene) in South Carolina. Tampa Formation (upper Oligocene and lower Miocene) in southern Florida.

Family VERMETIDAE Rafinesque, 1815
Genus *Anguinella* Conrad, 1845

Anguinella virginica (Conrad, 1839)
Plate 4, figure 4

Serpula virginica Conrad, 1839, printed inside the back cover.
Anguinella virginiana Conrad. Conrad, 1845, p. 77–78, Pl. 44, fig. 4.
Anguinella virginiana Conrad. Conrad, 1863*b*, p. 568.
Vermetus? (*Anguinella*) *virginica* Conrad. Dall, 1892, p. 306. [In part].
Vermicularia (*Anguinella*) *virginica* Conrad. Dall, 1915, p. 96. [In part].
Lemintina virginica (Conrad). Gardner, 1948*b*, p. 202, Pl. 24, fig. 12.
Not—
Anguinella virginiana Conrad. Whitfield, 1894, p. 132–133, Pl. XXIV, figs. 1–5.
Vermetus virginicus (Conrad). Martin, 1904, p. 232–233, Pl. LV, fig. 16.
Lemintina virginica (Conrad). Vokes, 1957, p. 26, Pl. 21, fig. 24.

Discussion.—Conrad named the genus and species based on specimens from Urbanna, Middlesex County, Va. The taxon is found in that area in beds now known as the Cobham Bay Member of the Eastover Formation (upper Miocene), in which it is locally very abundant. The genus and species is known only from the Eastover. Dall (1892) believed that the taxon was an annelid but placed it in the Gastropoda. Examination of the young stages reveals turrited, tightly coiled early whorls, which later uncoil and in many cases become relatively straight. In some areas the taxon occurs in masses with the straight or intertwining tubes directed upwards. The genus *Anguinella* closely resembles the West Coast genus *Tripsycha* (Keen), both in coiling and exterior sculpture, and the two may be congeneric.

Type information.—Moore (1962) cited six probable syntypes in the Academy of Natural Sciences of Philadelphia (ANSP 15561). Type locality: "Near Urbanna, Va." (Conrad, 1839).

Figured specimen.—Specimen (USNM 405311) from the mouth of Whiting Creek, on the right bank of the Rappahannock River, Middlesex County, Va.

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Superfamily NATICOIDEA Gray, 1840
Family NATICIDAE Gray, 1840
Subfamily SININAE Woodring, 1928
Genus *Sinum* Röding, 1798

Sinum imperforatum Dall, 1915
Plate 26, figure 5

Sinum imperforatum Dall, 1915, p. 109, Pl. 5, fig. 8.
Sinum imperforatum Dall. Dall, 1916, p. 520.
Sinum imperforatum Dall. Kellum, 1926, p. 40.
Sinum imperforatum Dall. Mansfield, 1937, p. 178.
Sinum imperforatum Dall. Richards, 1943, p. 523, Pl. 85, fig. 8.

Discussion.—*Sinum imperforatum* is somewhat thicker-shelled and slightly higher-spired than the later *Sinum fragilis* (Conrad, 1930). *S. imperforatum* is common in the Haywood Landing Member of the Belgrade Formation.

Type information.—Holotype: USNM 166107. Type locality: Tampa silex beds from the vicinity of the Hillsboro River, Fla.

Figured specimen.—Specimen (USNM 405312) from Silverdale, Onslow County, N.C. (locality 30).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Order NEOGASTROPODA
Suborder STENOGLOSSA
Superfamily MURICOIDEA Rafinesque, 1815
Family MURICIDAE Rafinesque, 1815
Subfamily RAPANINAE Gray, 1853
Genus *Tritonopsis* Conrad, 1865

Tritonopsis gilletti (Richards, 1943)
Plate 26, figure 11

Rapana gilletti Richards, 1943, p. 524–525, Pl. 83, fig. 5.
Rapana gilletti Richards. Carter et al., 1988, p. 82, Pl. 7, fig. 51.

Discussion.—*Tritonopsis gilletti* Richards generally resembles *R. vaughani* Mansfield, 1937, but it differs in having more rounded whorls and weaker spiral ribs. *Tritonopsis gilletti* is common in the Haywood Landing Member of the Belgrade Formation and is only known from that unit.

Type information.—Holotype: ANSP 15840. Type locality: Gillette's marl pit, Silverdale, Onslow Coun-

ty, N.C.

Figured specimen.—Specimen (USNM 405313) from Belgrade, Onslow County, N.C.

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Tritonopsis biconica (Dall, 1915)
Plate 26, figure 10

Rapana biconica Dall, 1915, p. 79, Pl. 13, fig. 10.
Rapana biconica Dall. Mansfield, 1937, p. 137.
Rapana vaughani Mansfield. Richards, 1943, p. 524, Pl. 85, fig. 6. [Not *Rapana vaughani* of Mansfield, 1937].
Chesathais biconicus (Dall). Petuch, 1988e, p. 112, fig. 48 (p. 115).

Discussion.—*Tritonopsis biconica* differs from *T. gilletti* (Richards) in having an angular body whorl and no strong spiral ribs. Sculpture on *T. biconica* consists of numerous, thin, raised spiral threads. Petuch's (1988e) placement of *T. biconica* in his genus *Chesathais* is erroneous; *Chesathais* Petuch, 1988 is based on a small, multiribbed form of *Ecphora meganae meganae* Ward and Gilinsky, 1988 and is not closely related to the genus *Tritonopsis*. *Tritonopsis biconica* is common in the Haywood Landing Member of the Belgrade Formation.

Type information.—Holotype: USNM 165092. Type locality: "Tampa silex beds at Ballast Point, Tampa Bay, Florida" (Dall, 1915, p. 79).

Figured specimen.—Specimen (USNM 405314) from Belgrade, Onslow County, N.C. (locality 29).

Stratigraphic and geographic range.—Haywood Landing Member of the Belgrade Formation (upper Oligocene and lower Miocene) in North Carolina.

GENUS *Ecphora* Conrad, 1843

Ecphora kochi Ward and Gilinsky, 1988
Plate 4, figure 8

Ecphora kochi Ward and Gilinsky, 1988, p. 10–11, Pl. 4, figs. 3, 4.
Ecphora (*Ecphora*) *kochi* Ward and Gilinsky. Petuch, 1988e, p. 67–68, fig. 31a,b(?) (p. 76). [Issue date 2/15/89].

Diagnosis.—Shell large, thick, umbilicate pyriform, with four thick, raised, sinuous, spiral ribs, which are T-shaped in cross section and become lower to the body whorl in adult stages.

Description.—Shell large, thick, pyriform, with a moderately flaring umbilicus and moderate-sized, oval aperture. Ornamentation consists of four thick, spiral ribs, which are T-shaped in section, and well-raised above the body whorl in the younger stages, but which become lower in the adult stages. Ribs at first smooth, becoming somewhat undulating and finally scaly and irregular due to numerous growth pauses and interruptions. Ribs separated by wide, deep, subrounded interspaces devoid of spiral lines, but exhibiting very fine axial, incremental growth lines in the early stages, which become increasingly more pronounced in the adult stags. Apex of the ribs flat and exhibiting a single, slightly impressed striae in the early whorls, several finer lines appearing in the late stages. Upper rib is the shoulder of a nearly flat shelf, which is fused to the early whorls at the level of the second-lowest rib. Suture at this juncture slightly impressed. Columella below the lowest rib greatly constricted and then again flaring at the moderately large umbilicus. Early growth pauses of the siphonal notch give the siphonal fasciole an irregularly scaly appearance. Gap between the columella below the lowest rib and the parietal wall of the aperature wide and lunate in outline. Smaller gap apparent between the lowest and second lowest ribs. Aperture siphonostomatous, oval in outline, with a long, thin, deeply impressed siphonal notch. Small, sharply defined, adapical channel in the aperture proximal to the body whorl at the second-lowest rib and near the suture. Aperture glazed with a white, aragonitic shell substance, which obscures the internal manifestation of the exterior ribs when that material is preserved.

The holotype (USNM 405315) (incomplete) is 89.6 mm in height and 85.9 mm in width.

Discussion.—*Ecphora kochi* differs from *E. quadricostata* (Say, 1824) in having thicker, higher ribs and a smaller, less flaring umbilicus. The adapical apertural channel in *E. kochi* is sharply excavated, while in *E. quadricostata* it consists only of a wide, shallow undulation. *Ecphora kochi* is more like *E. quadricostata* than *E. gardnerae gardnerae* Wilson, 1987, in that it has ribs, at first well-raised, which become lower to the body whorl in the adult stages. In *E. gardnerae gardnerae* the ribs remain profoundly high, thick, and noticeably T-shaped, even in the late stages. *Ecphora kochi* differs from *E. gardnerae whiteoakensis*, new subspecies, in having higher, somewhat less robust ribs and a wider umbilicus. In addition, the adapical apertural channel is scarcely noticeable in *E. g. whiteoakensis* and *E. gardnerae gardnerae* while it is

sharply defined in *E. kochi*.

Ecphora kochi seems to be an intermediate form between the strong-ribbed *E. gardnerae gardnerae* and the thin-ribbed *E. quadricostata*. It shares the characteristics of both and yet is distinct. The species is common in the Cobham Bay Member of the Eastover Formation, especially in its type area, Cobham Wharf, but is usually in fragmentary condition.

Type information.—Holotype: USNM 405315. Type locality: Below Cobham Wharf, James River, Surry County, Va. (locality 3), in the Cobham Bay Member of the Eastover Formation.

Figured specimen.—Holotype (USNM 405315) from the type locality.

Stratigraphic and geographic range.—Cobham Bay Member of the Eastover Formation (upper Miocene) in Virginia.

Ecphora gardnerae whiteoakensis
Ward and Gilinsky, 1988
Plate 6, figure 7

Ecphora sp. Ward, 1984, p. 63, Pl. 8, fig. 6.
Ecphora sp. Ward, 1985*b*, Pl. 8, fig. 6.
Ecphora sp. Ward, 1985*c*, Pl. 8, fig. 6.
Ecphora sp. Ward, 1987, p. 135, Pl. 8, fig. 6.
Ecphora gardnerae whiteoakensis Ward and Gilinsky, 1988, p. 9–10, Pl. 4, figs. 1, 2.
?*Ecphora (Ecphora) whiteoakensis* Ward and Gilinsky. Petuch, 1988*e*, p. 94–95, fig. 45 (p. 101). [Issue date 2/15/89].
Ecphora gardnerae whiteoakensis Ward and Gilinsky. Ward, 1989, p. 85, Pl. 8, fig. 6.
Ecphora gardnerae whiteoakensis Ward and Gilinsky. Ward and Powars, 1989, p. 38, Pl. 12, fig. 6.
Ecphora sp. Ward, *in* Johnson et al., 1990, Pl. 8, fig. 6.

Diagnosis.—Shell moderate in size, thick, umbilicate pyriform, with four thick, low, smooth, spiral ribs, which are weakly T-shaped in cross section.

Description.—Shell moderate in size, pyriform, with a relatively small umbilicus and ovate aperture. Ornamentation consists of four thick, low, spiral ribs. Ribs adhere closely to the body whorl in all stages and are only weakly T-shaped. Ribs are smooth and regular, becoming somewhat irregular and sinuous in late stages due to growth interruptions. Ribs separated by wide, flat interspaces devoid of spiral lines but exhibiting very fine, axial, incremental growth lines in the early stages, which become increasingly pronounced in the later stages. Apex of the ribs flat and exhibiting a single, feebly impressed lirae. Upper rib is the shoulder of a nearly flat shelf, which is fused to the previous whorl at the level of the second-lowest rib. Suture at this juncture very slightly impressed. Columella below the lowest rib greatly constricted and then again slightly flaring at the moderately small umbilicus. Numerous, close-spaced growth pauses of the siphonal notch give the siphonal fasciole a regularly scaly appearance. Small, thin gap apparent between the columella and the parietal wall of the aperture below the lowest rib and the second-lowest rib. Aperture siphonostomatus, oval in outline, with a long, then deeply impressed siphonal notch. Adaptical channel in the aperture expressed by only a slight flexure proximal to the body whorl at the second-lowest rib and near the suture. Aperture moderately notched at the termination of the four ribs. Aperture lacking the characteristic glazing of white aragonitic shell material due to solution on the holotype, but present on some individuals.

The holotype (USNM 380706), incomplete, measures 70.2 mm in height and 66.5 mm in width. The paratype (USNM 405316) (not figured), also incomplete, is 72.0 mm in height and 64.0 mm in width.

Discussion.—*Ecphora gardnerae whiteoakensis* differs from its close relative *E. gardnerae gardnerae* Wilson, 1987, only in its ribbing. The ribs of *E. g. gardnerae* are robust, high, and strongly T-shaped, even in the adult stages. *Ecphora g. whiteoakensis* has somewhat smaller ribs than *E. gardnerae gardnerae* but they differ mostly in being set low to the body whorl. The differences in the two types of ribs are most profound at their termination on the aperture. In addition, the flat, upper surface of the ribs of *E. g. gardnerae* are more often multi-striate, while those of *E. g. whiteoakensis* possess a single incised spiral line. Of less importance, but noted on the unbroken specimens available, is the fact that the aperture of *E. g. gardnerae* is proportionately smaller than that of the new subspecies. The assignment of Petuch's (1988*e*, fig. 45, p. 101) specimen from Sarasota, Florida, is tentative.

Ecphora g. whiteoakensis is common in the Claremont Manor Member of the Eastover Formation, especially on the Mattaponi River near White Oak Landing, the type locality, and in the vicinity of Claremont on the James River.

Type information.—Holotype: USNM 380706. Paratype (USNM 405316). Type locality: White Oak Landing, on the Mattaponi River, King William County, Va. (locality 8), in the Claremont Manor

Member of the Eastover Formation. The paratype was found at the same locality.

Figured specimen.—Holotype (USNM 380706).

Stratigraphic and geographic range.—Claremont Manor Member of the Eastover Formation (upper Miocene) in Virginia.

Ecphora gardnerae gardnerae Wilson, 1987
Plate 6, figure 8; Plate 10, figures 1, 2

Ecphora quadricostata (Say). Conrad, 1861, p. 83–84. [In part; not Pl. 48, fig. 2].

Ecphora quadricostata (Say). Dall, 1890, p. 125. [In part].

Rapana (Ecphora) quadricostata (Say). Martin, 1904, p. 207–208, Pl. LII, figs. 1–2.

Ecphora quadricostata (Say). Smith, 1905, p. 360, Pl. XXX, figs. 6–8.

Ecphora quadricostata (Say). Vokes, 1957, p. 30, Pl. 25, fig. 2.

Ecphora (Ecphora) gardnerae Wilson, 1987, p. 22–24, fig. 1.

Ecphora gardnerae gardnerae Wilson. Ward and Gilinsky, 1988, p. 7, Pl. 3, figs. 3, 4.

Ecphora gardnerae Wilson. Petuch, 1988*a*, Pl. 1, fig. 1. [Issue date 3/16/88].

Ecphora gardnerae Wilson. Petuch, 1988*c*, p. 44, Pl. 8, fig. 9. [Issue date 12/15/88].

Ecphora gardnerae gardnerae Wilson. Petuch, 1988*e*, p. 17, fig. 6c; p. 92–93, fig. 43 (p. 99); p. 102 (no fig. no.). [Issue date 2/15/89].

Ecphora gardnerae angusticostata Petuch. Petuch, 1988*e*, fig. 44c (p. 100). [Not same species as Petuch's holotype of *Ecphora gardnerae angusticostata* = *E. meganae meganae* Ward and Gilinsky, 1988]. [Issue date 2/15/89].

Diagnosis.—Shell large, thick, umbilicate pyriform, with four very thick, highly raised, spiral ribs, which are strongly T-shaped in cross section and which become higher in the later stages.

Description.—Shell large, thick, pyriform, with moderately large umbilicus and ovate aperture. Ornamentation consists of four, thick, high, spiral ribs. Ribs stand high off the body whorl, more so in the later stages, and are strongly T-shaped in section. Ribs are smooth and regular, becoming slightly irregular and sinuous in the late stages due to growth interruptions or rests. Ribs separated by wide, nearly flat interspaces devoid of spiral lines but exhibiting very fine, axial, incremental growth lines in the early stages, which become somewhat more pronounced in the late stages. Apex of the ribs flat to slightly rounded and exhibiting a variable number of thin, feeble impressed striae. Upper rib is the shoulder of a nearly flat shelf, which is fused to the previous whorl at the level of the second-lowest rib. Suture at this juncture very slightly impressed. Columella below the lowest rib greatly constricted and then again slightly flaring at the moderately small umbilicus. A number of widely spaced, strongly developed growth pauses of the siphonal notch give the siphonal fasciole a rough, scaly appearance. Gap between the columella and the parietal wall below the lowest rib wide and short. A small gap between the second-lowest rib and the lowest rib. Aperture siphonostomatous, oval in outline, with a long, thin, deep siphonal notch. Adaptical channel in the aperture expressed only by a slight flexure proximal to the body whorl at the second-lowest rib and near the suture. Aperture deeply notched at the termination of the four ribs. Aperture glazed with a white, aragonitic shell substance, which obscures the internal manifestation of the ribs progressively distal to the aperture.

Discussion.—*Ecphora gardnerae gardnerae* Wilson, 1987 differs from *E. meganae williamsi*, new species, in having thicker, higher, and more T-shaped ribs. In addition it lacks the spiral striae obvious on specimens from the Calvert and Choptank Formations. *Ecphora gardnerae gardnerae* differs from *E. g. whiteoakensis* in having high ribs. *Ecphora kochi* differs in having ribs, at first high, that become progressively lower to the body whorl in the adult stages. The ribs on *E. kochi* are also less thick and not as strongly T-shaped.

Ecphora gardnerae gardnerae Wilson is a strongly characterized taxon that is common in the Windmill Point beds of the St. Marys Formation. *Ecphora gardnerae germonae* from the Little Cove Point beds is somewhat wider and has a wider spiral angle than *E. g. gardnerae* from the Windmill Point. In the lower part of the Claremont Manor Member of the Eastover Formation, *E. g. gardnerae* is replaced by *E. g. whiteoakensis*, new subspecies.

Type information.—Holotype: USNM 647519. Type locality: St. Marys River, St. Marys County, Md. The type is based on Martin's figured (1904, Pl. LII, fig. 1) specimen.

Figured specimens.—Plate 6, figure 8 Specimen (USNM 258348) from just above Sunken Meadow Creek, Surry County, Va. (USGS locality 26041). Plate 10, figures 1, 2: Specimen (USNM 405317) from Chancellor Point, St. Marys River, St. Marys County, Md. (locality 12).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Mio-

cene) in Maryland and Virginia. Claremont Manor Member of the Eastover Formation (upper Miocene) in Virginia.

Ecphora gardnerae germonae Ward and Gilinsky, 1988
Plate 13, figures 1, 2

Ecphora quadricostata (Say). Martin, 1904, p. 207, Pl. LII, fig. 2 (adolescent).

Ecphora gardnerae germonae Ward and Gilinsky, 1988, p. 6–7, Pl. 3, figs. 1, 2 [Published 3/15/88].

Ecphora asheri Petuch, 1988*a*, p. 5, Pl. 1, figs. 2, 3, 4. [Issue date 3/16/88].

Ecphora asheri Petuch. Petuch, 1988*c*, p. 44, Pl. 8, fig. 6. [Issue date 12/15/88].

Ecphora (Ecphora) germonae Ward and Gilinsky. Petuch, 1988*e*, p. 92, fig. 42 (p. 98). [Issue date 2/15/89].

Ecphora (Ecphora) asheri Petuch. Petuch, 1988*e*, p. 91–92, fig. 41 (p. 97). [Issue date 2/15/89].

Diagnosis.—Shell moderately large, thick, umbilicate pyriform, with four, thick, moderately high, somewhat striate spiral ribs, that are moderately T-shaped in cross section.

Description.—Shell moderately large in size, pyriform, with a relatively small umbilicus and ovate aperture. Ornamentation consists of four thick, moderately high, spiral ribs. Ribs thin and pronounced in the young stages, becoming thicker and more T-shaped in the adult stages. Ribs are somewhat sinuous due to irregularities in the incremental growth of the shell. Ribs separated by wide, flat interspaces devoid of spiral lines but exhibiting very fine incremental growth lines in the early stages that become increasingly pronounced in later stages. Apex of the ribs wide, very slightly rounded, and exhibiting up to four incised spiral striae on the summit. Upper rib is the raised shoulder of a nearly flat shelf, which is fused to the previous whorl at the level of the second-lowest rib. Suture at this juncture very slightly impressed. Columella below the lowest rib greatly constricted and then again flaring at the moderately small umbilicus. A number of widely spaced growth pauses of the siphonal notch give the siphonal fasciole a regularly scaly appearance. Moderately wide, triangular gap apparent between the columella and the parietal wall of the aperture below the lowest rib. Aperture siphonostomatous, oval in outline, with a moderately long, thin, deeply impressed siphonal notch. Adapical channel in the aperture very weakly expressed just below the level of the second lowest rib and near the suture. Aperture strongly notched at the termination of the four ribs. Aperture heavily glazed by white aragonitic shell material, which obscures the internal manifestation of the ribs deep in the aperture but does not completely infill the ribs at the aperture.

Measurements (in millimeters).—Holotype (USNM 405318): height 78.0, width 67.8. Paratypes: (USNM 424306), height 66.9, width 55.0; (USNM 424307) height 66.0, width 59.0.

Discussion.—*Ecphora gardnerae germonae* is found only in the Little Cove Point beds of the St. Marys Formation, whereas *E. g. gardnerae* Wilson occurs in the Windmill Point beds of the same formation. *Ecphora g. germonae* differs from *E. g. gardnerae* in being proportionally stouter and in having ribs that are set closer to the body whorl. In that regard, the subspecies is most related to *E. meganae williamsi* Ward and Gilinsky from the Boston Cliffs Member of the Choptank Formation, but *E. g. germonae* has thicker, more elevated ribs than that species and appears to be an intermediate species in the evolutionary series between *E. meganae williamsi* and *E. g. gardnerae*. Unusual specimens possess extra riblets of smaller size but considerable thickness. *Ecphora asheri* Petuch is merely an *E. gardnerae germonae* with a fifth, weakly developed rib. Petuch (1988*c*, p. 91) admitted that his *E. asheri* and *E. gardnerae germonae* may be conspecific but incorrectly stated that his name would have priority. The only date on Vol. 1, No. 1 of the Bulletin of Paleomalacology is "Winter 1988." The earliest verified mailing of that bulletin was obtained from the Academy of Natural Sciences of Philadelphia and was postmarked at Boca Raton, Florida, on March 16, 1988. This date is one day later than that on Ward and Gilinsky's (March 15, 1988) article.

Type information.—Holotype: USNM 405318. Paratypes: USNM 424306; USNM 424307. Type locality: 0.8 km south of Little Cove Point, Calvert County, Md., in 0.93 m thick shell bed, 6 m above mean sea level, in the Little Cove Point beds of the St. Marys Formation. Paratypes from near type locality at Chesapeake Ranch Club, Little Cove Point, Calvert County, Md.

Figured specimen.—Holotype: USNM 405318.

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point unit (lower upper Miocene) in Maryland.

Ecphora meganae williamsi Ward and Gilinsky, 1988

Plate 15, figures 1, 2

Ecphora meganae williamsi Ward and Gilinsky, 1988, p. 5–6, Pl. 2, figs. 5, 6.

Ecphora meganae williamsi Petuch, 1988c, p. 44, Pl. 8, figs. 2, 3. [Issue date 12/15/88].

Ecphora meganae williamsi Petuch, 1988e, p. 90–91, fig. 4 (p. 96); p. 122 (no fig. no., upper left). [Issue date 2/15/89].

Diagnosis.—Shell moderately large, thick, umbilicate pyriform, with four thick, low, spiral ribs which are slightly T-shaped in section.

Description.—Shell moderately large, thick, pyriform, with a moderately flaring umbilicus and moderately small aperture. Ornamentation consists of four thick, spiral ribs, which are only slightly T-shaped in cross section and are set close to the body whorl. Secondary, very fine, spiral striae are apparent between the primary ribs but are most apparent on the columella below the lowest rib. Apex of the ribs somewhat rounded and incised by several very faint striae. Ribs smooth but becoming somewhat irregular in the late stages. Ribs separated by interspaces slightly wider than the ribs that exhibit very fine axial incremental lines that become more obvious in the adult stages. Young stages (not preserved in the holotype) with the upper rib flattened and reflected upward. Upper rib is the shoulder of a nearly flat shelf, which is fused to the early whorls at the level of the second-lowest rib. Suture at this juncture only slightly impressed. Columella below the lowest rib constricted and then flaring at the moderately small umbilicus. Early growth pauses of the siphonal notch are closely spaced and give the siphonal fasciole a slightly scaly appearance. Gap between the columella below the lowest rib and the parietal wall of the aperture very narrow. Aperture siphonostomatous, slightly oval in outline, with a long, thin, deeply impressed siphonal notch. Small, rounded, adaptical channel in the aperture proximal to the body whorl at the second-lowest rib and near the suture. Aperture moderately notched at each of the ribs. Aperture glazed with a white, aragonitic shell substance, which obscures the internal manifestation of the exterior ribs when that material is preserved.

The holotype (USNM 405319) is incomplete but measures 55.4 mm in height and 48.0 mm wide.

Discussion.—*Ecphora meganae williamsi* is closely related to *E. meganae meganae* in that both have the same general outline, aperture and umbilicus size, and the flattened, upwardly reflected, upper rib in the young stages. *Ecphora meganae williamsi* differs, however, in having consistently thicker ribs that are closer to the body whorl. The ribs on *E. meganae meganae* are thinner and higher on the majority of specimens. The ribs of *E. gardnerae germonae* are also thick like *E. m. williamsi* but are flatter on the apex, stand high off the body whorl, and are markedly T-shaped in section. The inter-rib areas and columella below the fourth rib on *E. meganae williamsi* are markedly striated with thin, incised, fine spiral lines. Such striae are obsolete to rare in the *Ecphora* lineage species that occur stratigraphically higher than *E. m. williamsi*. The immediately succeeding species, *E. gardnerae germonae*, has very fine striae only on the columella, and they are exhibited best on juvenile specimens.

Ecphora meganae williamsi most commonly has four thick ribs and no trace of secondary riblets. However, a few specimens have been collected that exhibit several riblets. A specimen (USNM 647525) collected from the Boston Cliffs Member (Bed 19) of the Choptank Formation by Dwight Taylor in 1940 had four secondary riblets in the following configuration:

1. A large secondary on the shelf above the first primary.
2. A large secondary, somewhat smaller than the first, between the first and second primaries.
3. A very small secondary riblet between the second and third primary ribs.
4. A large secondary, somewhat smaller than the first, just below the fourth rib.

Another specimen (fragment of the final whorl) of *E. meganae williamsi* found at Governor Run, probably in the Boston Cliffs Member, by S. F. Blake around 1933–1934 had strong riblets between the second and third ribs and just below the fourth rib. In all other respects, these two specimens conform to the characteristics of typical *E. meganae williamsi*.

Type information.—Holotype: USNM 405319. Type locality: Below Flag Ponds, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 17).

Figured specimen.—Holotype (USNM 405319).

Stratigraphic and geographic range.—Boston Cliffs Member (Bed 19) of the Choptank Formation (upper middle Miocene) in Virginia and Maryland.

Ecphora meganae meganae Ward and Gilinsky, 1988
Plate 19, figures 6, 7

Ecphora quadricostata (Say). Dall, 1890, p. 125. [In part].
Ecphora quadricostata var. *umbilicata* (Wagner). Martin, 1904, p. 209, Pl. LII, fig. 4.
Ecphora quadricostata umbilicata (Wagner). Shimer and Shrock, 1944, p. 505, Pl. 208, fig. 4.
Ecphora quadricostata var. *umbilicata* (Wagner). Vokes, 1957, p. 30, Pl. 25, fig. 3.
Ecphora sp. Germon et al., 1987, p. 28, fig. 8.
Ecphora meganae meganae Ward and Gilinsky, 1988, p. 4–5, Pl. 2, figs. 1–4. [Published 3/15/88].
Chesathais lindae Petuch, 1988*a*, p. 9, Pl. 2, figs. 3, 4, 5. [Issue date 3/16/88].
Chesathais ecclesiasticus (Dall). Petuch, 1988*a*, p. 8–9, Pl. 2, figs. 1, 2. [Issue date 3/16/88].
Ecphora (*Trisecphora*) *patuxentia* Petuch, 1988*a*, p. 8, Pl. 1, figs. 9–11. [Issue date 3/16/88].
Ecphora choptankensis Petuch, 1988*a*, p. 10, Pl. 1, figs. 7, 8. [Issue date 3/16/88].
Ecphora rikeri Petuch, 1988*a*, p. 12, Pl. 1, figs. 5, 6. [Issue date 3/16/88].
Ecphora calvertensis Petuch, 1988*a*, p. 13–14, Pl. 2, figs. 7, 8. [Issue date 3/16/88].
Ecphora (*Trisecphora*) sp. Petuch, 1988*b*, p. 25, Pl. 1, fig. 6. [Issue date 6/15/88].
Ecphora (*Trisecphora*) *martini* Petuch, 1988*b*, p. 26, 28, Pl. 2, figs. 3, 4, 7. [Issue date 6/15/88].
Ecphora (*Trisecphora*) *patuxentia* Petuch, 1988*b*, p. 27, Pl. 2, figs. 5, 6. [Issue date 6/15/88].
Ecphora (*Trisecphora*) *smithae* Petuch, 1988*b*, p. 28, Pl. 1, figs. 1–4, 7. [Issue date 6/15/88].
Ecphora choptankensis Petuch. Petuch, 1988*c*, p. 44, Pl. 8, fig. 1. [Issue date 12/15/88].
Ecphora calvertensis Petuch. Petuch, 1988*c*, p. 44, Pl. 8, fig. 7. [Issue date 12/15/88].
Ecphora rikeri Petuch. Petuch, 1988*c*, p. 44, Pl. 8, fig. 8. [Issue date 12/15/88].
Chesathais ecclesiasticus (Dall). Petuch, 1988*c*, p. 46, Pl. 9, figs. 3, 4. [Issue date 12/15/88].
Chesathais lindae Petuch. Petuch, 1988*c*, p. 46, Pl. 9, fig. 5. [Issue date 12/15/88].
Ecphora (*Trisecphora*) *patuxentia* Petuch. Petuch, 1988*c*, p. 46, Pl. 9, fig. 9. [Issue date 12/15/88].
Ecphora (*Trisecphora*) *smithae* Petuch. Petuch, 1988*c*, p. 46, Pl. 9, fig. 11. [Issue date 12/15/88].
Ecphora (*Trisecphora*) *patuxentia patuxentia* Petuch. Petuch, 1988*e*, p. 32 (fig. only); p. 53, fig. 24 a–c (p. 60). [Issue date 2/15/89].
Ecphora (*Trisecphora*) *martini* Petuch. Petuch, 1988*e*, p. 52, fig. 22 (p. 58). [Issue date 2/15/89].
Echpora (*Trisecphora*) *smithae* Petuch. Petuch, 1988*e*, p. 52–53, fig. 23 (p. 59). [Issue date 2/15/89].
Echpora (*Trisecphora*) *patuxentia shattucki* Petuch, 1988*e*, p. 53–54, fig. 25 a–c (p. 61). [Issue date 2/15/89].
Ecphora (*Ecphora*) *calvertensis* Petuch. Petuch, 1988*e*, p. 64–65, fig. 26 (p. 71), fig. 27 (p. 72). [Issue date 2/15/89].
Ecphora (*Ecphora*) *rikeri* Petuch. Petuch, 1988*e*, p. 65, fig. 28 (p. 73). [Issue date 2/15/89].
Ecphora (*Ecphora*) *meganae* Ward and Gilinsky. Petuch, 1988*e*, p. 66, fig. 29 a–d (p. 74). [Issue date 2/15/89].
Ecphora (*Ecphora*) *wardi* Petuch, 1988*e*, fig. 35, figs. A, B (p. 85). [Issue date 2/15/89]. Paratype only. Holotype = *E. tricostata*.
Ecphora (*Ecphora*) *choptankensis vokesi* Petuch, 1988*e*, p. 81–82, fig. 36 a–c (p. 86); p. 122 (no fig. number, lower right). [Issue date 2/15/89].
Ecphora (*Ecphora*) *choptankensis choptankensis* Petuch. Petuch, 1988*e*, p. 82–83, fig. 37 (p. 87). [Issue date 2/15/89].
Ecphora (*Ecphora*) *choptankensis delicata* Petuch, 1988*e*, p. 83, fig. 38 (p. 88). [Issue date 2/15/89].
Ecphora (*Ecphora*) *gardnerae angusticostata* Petuch, 1988*e*, p. 93–94, fig. 44 a, b (p. 100). [Issue date 2/15/89]. Holotype only. Paratype = *E. gardnerae gardnerae*.
Chesathais lindae Petuch. Petuch, 1988*e*, p. 114, fig. 52 (p. 118). [Issue date 2/15/89].
Ecphora (*Ecphora*) *meganae sandgatesensis* Petuch, 1988*e*, p. 130, Pl. A1, figs. B, C. [Issue date 2/15/89].
Ecphora (*Ecphora*) *rikeri harasewychi* Petuch, 1988*e*, p. 132, Pl. A2, fig. A. [Issue date 2/15/89].
Chesathais lindae drumcliffensis Petuch, 1988*e*, p. 135, Pl. A3, figs. E, F. [Issue date 2/15/89].
Chesathais lindae donaldasheri Petuch, 1988*e*, p. 134–135, Pl. A3, fig. D. [Issue date 2/15/89].

Diagnosis.—Shell of moderate size and thickness, umbilicate pyriform, with four thin, high, spiral ribs, which are only very slightly constricted near their bases.

Description.—Shell moderately large and thick, pyriform with a moderately flaring umbilicus and moderately small aperture. Ornamentation consists of four thin, spiral ribs, which are only slightly constricted near their bases. Ribs in later stages high off the body whorl. Secondary, very fine, spiral striae are apparent between the primary ribs but are most apparent on the columella below the lowest rib. On some specimens, as on the holotype, small accessory ribs may be present. On the holotype a fifth, very feebly expressed spiral rib present below the lowest primary rib. Apex of the ribs somewhat rounded and incised by several faint spiral striae. Ribs smooth but becoming somewhat irregular and uneven in the late stages. Ribs separated by wide interspaces that exhibit very fine, axial, incremental lines that become more pronounced in the adult stages. Young stages with the upper rib flattened and reflected upward. Upper rib is the shoulder of a nearly flat shelf, which is fused to the early whorls at the level of the second-lowest rib.

Suture at this juncture only slightly impressed. Columella below the lowest rib constricted and then flaring at the moderately small umbilicus. Early growth pauses of the siphonal notch are somewhat distantly spaced and give the siphonal fasciole a coarsely scaly appearance. Body whorl tightly coiled, leaving only a very thin gap between the columella and the parietal wall of the aperture. Aperture siphonostomatous, slightly oval in outline, with a long, thin, deeply impressed siphonal notch. Very small adapical channel in the aperture proximal to the body whorl at the second-lowest rib and near the suture. Aperture moderately notched at each of the ribs. Aperture glazed with a white, aragonitic shell substance, which obscures the internal manifestation of the exterior ribs when that material is preserved.

Holotype (USNM 405320) is 64.6 mm in height and 48.5 mm wide.

Discussion.—*Ecphora meganae meganae* is similar in form and outline to *E. meganae williamsi*, but differs from that taxon in having high, very thin ribs. Some of the forms of *E. tricostata tricostata* Martin have four thin ribs much like those of *E. meganae meganae*, but the two taxa are easily separated by the uncoiling characteristic of *E. tricostata tricostata* (see Pl. 23, figs. 7, 8). The highest rib in *E. meganae meganae* is strongly reflected upward in the juvenile stages, and that condition is much better developed and extends into later whorls than on *E. tricostata*. *Ecphora meganae meganae* is a morphologically variable species. However, my material, consisting of over 500 specimens from the Drumcliff Member of the Choptank Formation, reveals a continual series of variants. Martin's (1904) figure 4 (USNM 353140) and the holotype illustrate the most common form of *E. meganae meganae*. Martin (1904) and Vokes (1957) called that form *E. quadricostata* var. *umbilicata* (Wagner) [= *E. quadricostata* (Say)], but that species first occurs in the Pliocene and ranges from Virginia to Florida. The two species are superficially similar, but *E. quadricostata* lacks the flattened, upwardly directed upper rib of *E. meganae meganae*. It is clear that Petuch does not recognize variability within a species, or within a population of a species at a single locality. The lengthy synonomy can attest to that fact. The extreme variants of *E. meganae meganae* are very different, and without a large collection of individuals they might well be considered to be different species.

Petuch's taxa themselves can be laid out in a continuous morphological series, in which one morphotype grades into another without any clear break between his "species":

Chesathais ecclesiasticus [of Petuch (1988*a*, *c*) not Dall, 1915]
Small, low, multi-ribbed, small riblets, coarse striae, apertural denticles.

Chesathais lindae Petuch (1988*a*)
Small, low, multi-ribbed, small riblets, coarse striae, apertural denticles.

Chesathais lindae drumcliffensis Petuch (1988*e*)
Small, low, multi-ribbed, small riblets, coarse striae, apertural denticles.

Chesathais lindae donaldasheri Petuch (1988*e*)
Small, low, multi-ribbed, small riblets, coarse striae, apertural denticles, riblets becoming finer, moderate striae.

Ecphora calvertensis Petuch (1988*a*)
Small, four thick ribs, close to body whorl.

Ecphora (Ecphora) rikeri harasewychi Petuch (1988*e*)
Four low, moderately thick ribs, moderate striae.

Ecphora rikeri Petuch (1988*a*)
Four low, slightly thick ribs, moderate striae.

Ecphora (Ecphora) meganae [of Petuch (1988*e*)]
Four moderately high, slightly thick ribs, moderate striae.

Ecphora (Ecphora) wardi Petuch (1988*e*) [Paratype only]
Four moderately high, thin ribs, fine striae.

Ecphora (Ecphora) choptankensis vokesi Petuch (1988*e*)
Four moderately high, thin ribs, very faint striae, fourth rib reduced in size.

Ecphora (Ecphora) gardnerae angusticostata Petuch (1988*e*)
Four high, thin ribs, fine striae.

Ecphora (Ecphora) choptankensis Petuch (1988*a*)
Four high, very thin ribs, faint striae.

Ecphora (Ecphora) choptankensis delicata Petuch (1988*e*)
Four high, very thin ribs, fourth rib reduced in size, faint striae.

Ecphora (Ecphora) meganae sandgatesensis Petuch (1988*e*)
Four high, very thin ribs, fourth rib moderately reduced in size, faint striae.

Ecphora (Trisecphora) patuxentia shattucki Petuch (1988*e*)
Three thin high ribs, fourth rib much reduced,

low, fine striae.

Ecphora (Trisecphora) martini Petuch (1988*b*)
Three high, very thin ribs, fourth rib thin, low; very faint striae.

Ecphora (Trisecphora) sp. Petuch (1988*b*)
Three high, very thin ribs, fourth rib thin, very small, very low; very faint striae.

Ecphora (Trisecphora) smithae Petuch (1988*b*)
Three high, very thin ribs, fourth rib obsolete, no visible striae.

Ecphora (Trisecphora) patuxentia Petuch (1988*a*)
Three very high, very thin ribs, fourth rib obsolete, no visible striae.

Type information.—Holotype: USNM 405320. Type locality: Drumcliff, on the Patuxent River, St. Marys County, Md. (locality 16), in the Drumcliff Member (Bed 17) of the Choptank Formation.

Figured specimen.—Holotype (USNM 405320).

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member (Bed 12) (lower middle Miocene) and Calvert Beach Member (lower middle Miocene) in Maryland and Virginia. Choptank Formation, Drumcliff Member (middle middle Miocene) in Maryland.

Ecphora tricostata pamlico Wilson, 1987
Plate 23, figure 3, 4

Ecphora tricostata Martin, 1904, p. 209, Pl. LII, fig. 8.
Ecphora tricostata Martin. Richards and Harbison, 1942, p. 211, Pl. 7, fig. 15.
Ecphora sp. Ward, 1984, p. 58, Pl. 7, fig. 9.
Ecphora sp. Ward, 1985*b*, p. 58, Pl. 7, fig. 9.
Ecphora sp. Ward, 1985*c*, Pl. 7, fig. 9.
Ecphora pamlico Wilson, 1987, p. 24, Pl. 1, figs. 1, 2.
Ecphora sp. Ward, 1987, Pl. 7, fig. 9.
Ecphora pamlico Wilson. Ward and Gilinsky, 1988, p. 2–3, Pl. 1, figs. 1, 2.
Ecphorosycon pamlico (Wilson). Petuch, 1988*a*, Pl. 2, fig. 6. [Issue date 3/16/88].
Ecphora kalyx Petuch, 1988*a*, p. 14, Pl. 2, fig. 12. [Issue date 3/16/88].
Ecphorosycon pamlico (Wilson). Petuch, 1988*c*, p. 46, Pl. 9, fig. 1. [Issue date 12/15/88].
Ecphorosycon kalyx (Petuch). Petuch, 1988*c*, p. 46, Pl. 9, fig. 2. [Issue date 12/15/88].
Ecphorosycon kalyx ssp. Petuch, 1988*c*, p. 46, Pl. 9, fig. 10. [Issue date 12/15/88].
Ecphora (Trisecphora) schmidti Petuch, 1988*e*, p. 38; p. 133–134, Pl. A3, fig. Aa. [Issue date 2/15/89].
Ecphorosycon pamlico (Wilson). Petuch, 1988*e*, p. 44, fig. 17 a, b (p. 47). [Issue date 2/15/89].
Ecphorosycon kalyx (Petuch). Petuch, 1988*e*, p. 44–45, fig. 18 (p. 48). [Issue date 2/15/89].
Ecphora (Trisecphora) prunicola carolinensis Petuch, 1988*e*, p. 133, Pl. A3, fig. B. [Issue date 2/15/89].
Ecphora tricostata pamlico Wilson. Ward, 1989, p. 84, Pl. 7, fig. 9.
Ecphora tricostata pamlico Wilson. Ward and Powars, 1989, p. 33, Pl. 7, fig. 9.
Ecphora sp. Ward, *in* Johnson et al., 1990, Pl. 7, fig. 9.

Discussion.—Wilson (1987) considered *Ecphora tricostata pamlico* to be different from, but related to, the taxon figured here from the Calvert Formation. Only meager amounts of comparative material are available, but the Calvert and Pungo River forms appear to be identical. As pointed out by Wilson (1987), *E. tricostata pamlico* seems related to *E. jauberti* (Grateloup) from the Tortonian Stage of France, but differs from that taxon in that *E. tricostata pamlico* exhibits some degree of uncoiling, whereas the European form does not.

Ecphora tricostata pamlico is present as external molds in Bed 2 of the Calvert (Fairhaven Member) but is not common except in Bed 10 of the Calvert (Plum Point Marl Member). In that unit it is well-preserved. *Ecphora tricostata pamlico* differs from *E. tricostata tricostata* in having spiral sculpture that is expressed as angular costae rather than raised ribs. The two taxa are here provisionally kept at the rank of subspecies. Study of all the morphotypes included in the two taxa suggests that one suite merges with the other. If that proves correct, the senior synonym *E. tricostata* will stand, and its morphological variability will be much like *E. meganae meganae*.

Type information.—Holotype: USNM 647688. Paratype: USNM 647671. Type locality: "Pungo River Formation at Lee Creek, North Carolina" (Wilson, 1987).

Figured specimen.—Specimen (USNM 380701) from Plum Point, on the western shore of the Chesapeake Bay, Calvert County, Md.

Stratigraphic and geographic range.—Calvert Formation: Fairhaven Member (Bed 2) (lower Miocene) and Plum Point Marl Member (Bed 10) (lower middle Miocene) in Maryland. Pungo River Formation (lower and middle Miocene) in North Carolina.

Ecphora tricostata tricostata Martin, 1904
Plate 23, figures 1, 2, 7, 8

Ecphora tricostata Martin, 1904, p. 209–210, Pl. LII, figs. 5–7.
Ecphora tricostata Martin. Shimer and Shrock, 1944, p. 505, Pl. 208, fig. 5.

Ecphora quadricostata tricostata (Martin). Vokes, 1957, p. 30, Pl. 25, fig. 4.
Ecphora tricostata Martin. Blackwelder and Ward, 1976, p. 42, Pl. 1, fig. 3.
Ecphora tricostata. Powell, 1986, p. 51.
Ecphora tricostata Martin. Germon et al., 1987, p. 28, fig. 5.
Ecphora tricostata Martin. Ward and Gilinsky, 1988, p. 3–4, Pl. 1, figs. 3–5.
Ecphora (Trisecphora) prunicola Petuch, 1988*a*, p. 15, Pl. 2, figs. 9, 13. [Issue date 3/16/88].
Ecphora (Trisecphora) prunicola Petuch. Petuch, 1988*b*, Pl. 1, fig. 5. [Issue date 6/15/88].
Ecphora (Trisecphora) tricostata Martin. Petuch, 1988*b*, Pl. 2, figs. 1, 2. [Issue date 6/15/88].
Ecphora (Trisecphora) tricostata Martin. Petuch, 1988*c*, p. 46, Pl. 9, figs. 6, 7. [Issue date 12/15/88].
Ecphora (Trisecphora) prunicola Petuch. Petuch, 1988*c*, p. 46, Pl. 9, fig. 8. [Issue date 12/15/88].
Ecphora (Trisecphora) chamnessi Petuch, 1988*e*, p. 50–51, fig. 19 a–c (p. 55). [Issue date 2/15/89].
Ecphora (Trisecphora) tricostata Martin. Petuch, 1988*e*, p. 51, fig. 20 a–d (p. 56). [Issue date 2/15/89].
Ecphora (Trisecphora) prunicola Petuch. Petuch, 1988*e*, p. 51–52, fig. 21 a–c (p. 57). [Issue date 2/15/89].
Ecphora (Trisecphora) wardi Petuch, 1988*e*, p. 80–81, fig. 35 a–c (p. 85). [Issue date 2/15/89].
Ecphora (Trisecphora) eccentrica Petuch, 1988*e*, p. 6, 132; Pl. A2, figs. B, C, D. [Issue date 2/15/89].
Ecphora tricostata Martin. Carter et al., 1988, p. 84, Pl. 8, fig. 63.

Discussion.—The type lot of *Ecphora tricostata tricostata* Martin contains specimens that have nearly obsolete ribs and are markedly striate and others that have thin, high ribs and are very finely striate. The naming of *E. tricostata pamlico* (Wilson) in effect restricted the specific term *tricostata* to the latter forms—that is, to forms with pronounced high, thin elevated ribs. Martin's specimen (Martin, 1904, Pl. LII, fig. 8), I believe, is an *E. tricostata pamlico*, though Wilson (1987) believed it to be a different species.

In Maryland, *Ecphora tricostata tricostata* is known from Bed 2 and Bed 10 of the Calvert Formation. The species also occurs in the Pungo River Formation (lower and middle Miocene) in North Carolina. *Ecphora tricostata tricostata* is closely related to *E. tricostata pamlico*, whose range it overlaps, and they may be the same species. It lacks the coarsely striate appearance of *E. tricostata pamlico*. A few specimens of *E. tricostata tricostata* lack the fourth and lowest rib, but most exhibit at least a rudimentary expression of that rib. The lectotype has a very small fourth rib.

The ribs in *E. tricostata tricostata* are relatively thick in the early whorls, as are those of *E. tricostata pamlico*, but unlike that subspecies, they retain their prominence throughout the adult stages. Small riblets are present on the inter-rib area of a few specimens, but more commonly that area contains numerous, very small spiral striae. As pointed out in the section on *E. t. pamlico*, there may be a continuous series of morphotypes between the two "subspecies," suggesting they belong to a single taxon. This would rival the variation within *E. meganae meganae*.

Type information.—Holotype: (USNM) 353141. Type locality: Plum Point, Calvert County, Md.

Figured specimen.—Plate 23, figures 1, 2: USNM 405321, from Camp Roosevelt, on the western shore of the Chesapeake Bay, Calvert County, Md. Plate 23, figures 7, 8: USNM 405322, from the same locality.

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member (lower middle Miocene) in Virginia and Maryland. Pungo River Formation (lower and middle Miocene) in North Carolina.

Ecphora tampaensis (Dall, 1890)
Plate 26, figures 6–9

Rapana tampaensis Dall, 1890, p. 153–154.
Rapana (Ecphora) tampaensis Dall. Cossman, 1903, p. 65.
Rapana tampaënsis (Dall). Mansfield, 1937, p. 136–137.
Ecphora quadricostata (Say). Richards, 1943, p. 524, Pl. 85, fig. 16.
(?)*Ecphora* sp. Ward, 1984, p. 55, Pl. 6, fig. 12.
(?)*Ecphora* sp. Ward, 1985*b*, Pl. 6, fig. 12.
Ecphorosycon tampaensis (Dall). Petuch, 1988*e*, p. 43–33, fig. 16 (p. 46).
Not—
Rapana tampaensis Dall var.? Dall, 1892, p. 244, Pl. 20, fig. 14.
Ecphora tampaënsis (Dall). Martin, 1904, p. 210–211, Pl. III, figs. 9, 10.

Discussion.—Dall's (1890) description was based, as he noted, on two incomplete individuals (syntypes, USNM 112068). Those individuals preserved enough of the characteristics of the species that, when he obtained and figured a complete individual (Dall, 1915, Pl. 13, fig. 8, USNM 165096), no additional description was necessary. Present collections from the Haywood Landing Member of the Belgrade Formation in North Carolina exhibit all of the characteristics of the Tampa specimens.

Ecphora tampaensis (Dall) is extremely variable in rib

width. The two specimens on which Dall based the species have relatively wide ribs, while the specimen he later figured has very thin, high ribs. This characteristic can be seen in the Haywood Landing material from North Carolina, in which the ribbing varies from very wide to very thin. However, the configuration and spacing of the ribs are very consistent in both the North Carolina and Florida collections.

The most obvious characteristic about *E. tampaensis* is the presence of five primary ribs. The fifth occurs high on the whorl and close to the suture. Also obvious are the strong secondary ribs, which extend over the columella. In later forms these ribs become increasingly feeble and poorly defined.

It is clear that *Ecphora tampaensis* contains, in its genetic makeup, all of the characteristics that exhibit themselves in later species, and on which those species are differentiated. Among those are rib shapes from thin and straight to wide and T-shaped, regular to irregular numbers of ribs, and spiral striae on the ribs and interrib areas. The inner surface of the outerlip is somewhat denticulate on some specimens, with one or two protuberances occurring on the areas corresponding to the exterior interribs. This condition apparently occurred at growth pauses and is common in *E. tampaensis* but relatively rare in later *Ecphoras*.

Type information.—Syntypes: USNM 112068. Plesiotype: USNM 165096, figured by Dall (1915). Type locality: "Ballast Point silex beds, Tampa Bay, Florida" (Dall, 1890, p. 153). The syntypes were collected by Frank Burns; the plesiotype was collected by E. J. Post.

Figured specimen.—Plate 26, figures 6, 7: Specimen (USNM 405323), from Belgrade, Onslow County, N.C. (locality 29); Plate 26, figure 8: Specimen (USNM 405324), from the same locality; Plate 26, figure 9: Specimen (USNM 405325), from the same locality.

Stratigraphic and geographic range.—Tampa Limestone (upper Oligocene and lower Miocene) of south Florida. Haywood Landing Member of the Belgrade Formation (upper Oligocene and lower Miocene) of North Carolina. Possible occurrences: Edisto Formation (upper Oligocene and lower Miocene) in South Carolina, based on Dall's (1894, p. 301) specimen of an "*Ecphora quadricostata*" from the phosphate rock. Old Church Formation (upper Oligocene and lower Miocene) in Virginia, based on internal molds.

Subfamily THAIDINAE Suter, 1909
Genus *Urosalpinx* Stimpson, 1865

Urosalpinx subrusticus (d'Orbigny, 1852)
Plate 9, figure 2

Fusus errans Conrad, 1830, p. 211. [List only].
Fusus rusticus Conrad, new name, 1830, p. 230, Pl. IX, fig. 2. [Name and fig. only].
Fusus rusticus Conrad. Conrad, 1832, p. 18, Pl. 4, fig. 1.
Fusus subrusticus d'Orbigny, new name, 1852, p. 69. [Not *Fusus rusticus* Sowerby].
Neptunea rustica Conrad. Conrad, 1863*b*, p. 560.
Siphonalia rustica (Conrad). Conrad, 1868, p. 249.
Streptochetus rusticus (Conrad). Cossmann, 1901, p. 30, Pl. 4, fig. 20.
Urosalpinx rusticus (Conrad). Martin, 1904, p. 206, Pl. LI, figs. 16, 17.
Urosalpinx rusticus (Conrad). Vokes, 1957, p. 31, Pl. 24, fig. 12.
Urosalpinx rusticus (Conrad). Petuch, 1988*c*, p. 20, Pl. 2, figs. 3, 4.

Discussion.—*Urosalpinx subrusticus* is common in the St. Marys Formation in Maryland and Virginia. Specimens from the Windmill Point beds have thickened shells in the adults that somewhat obscure the spiral sculpture. This characteristic is not present on specimens from the Little Cove Point beds, but it is not believed to be of specific value.

Type information.—Type material: ANSP 13850. Type locality: St. Marys River, Md. [St. Marys County].

Figured specimen.—Specimen (USNM 405326) from above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland and Virginia. Little Cove Point beds (lower upper Miocene) in Maryland.

Subfamily TYPHINAE Cossmann, 1903
Genus *Typhis* Montfort, 1810

Typhis siphonifera Dall, 1915
Plate 26, figure 4

Typhis siphonifera Dall, 1915, p. 77–78, Pl. 13, fig. 9.
Typhis siphonifera Dall. Mansfield, 1937, p. 135–136.
Typhis (Typhinellus) siphoniferus Dall. Keen, 1944, p. 56, 67.
Typhis (Typhina) siphonifer Dall. Gertman, 1969, p. 149–150, Pl. 1, fig. 3a, 3b.

Discussion.—*Typhis siphonifera* is common in the Haywood Landing Member of the Belgrade Formation

in North Carolina, apparently its northernmost range. It also occurs in the Tampa Limestone in southern Florida.

Type information.—Holotype: USNM 165090. Type locality: Tampa Silex beds, Ballast Point, Tampa Bay, Fla.

Figured specimen.—Specimen (USNM 405327) from Silverdale Marl Company Quarry, Silverdale, Onslow County, N.C. (Lcality 30).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Superfamily BUCCINOIDEA Rafinesque, 1815
Family MELONGENIDAE Gill, 1867
Subfamily BUSYCONINAE Finlay and Marwick, 1937
Genus *Busycon* Röding, 1798

Busycon fusiforme (Conrad, 1840)
Plate 13, figure 9

Fulgur fusiformis Conrad, 1841, back cover of pub. [Date according to Dall, 1893].
Fulgur fusiforme Conrad. Conrad, 1854, p. 318. [Conrad says pub. in 1839].
Busycon fusiforme Conrad. Conrad, 1861, p. 82, Pl. 46, fig. 3. [Conrad said pub. in 1840].
Busycon fusiforme Conrad. Conrad, 1863*b*, p. 561.
Busycon fusiforme Conrad. Conrad, 1868, p. 267, Pl. 23, fig. 4.
Fulgur fusiforme Conrad. Martin, 1904, p. 178–179, Pl. XLV, figs. 2, 3a, 3b.
Busycon cf. *fusiforme* (Conrad). Smith, 1945, p. 246, Pl. 22, figs. 13, 14.
Busycon fusiforme (Conrad). Vokes, 1957, p. 34, Pl. 26, figs. 4, 6.
Turrifulgur fusiform (Conrad). Petuch, 1988*c*, p. 18, Pl. 1, figs. 10, 11.
Turrifulgur turriculus Petuch, 1988*c*, p. 24–25, Pl. 1, figs. 14, 15. [Issue date 12/15/88].

Discussion.—The type of *Busycon fusiforme* was said by Conrad (1840) to have come from the Patuxent River, St. Marys County, Md. Conrad probably meant Drumcliff (locality 16, USGS loc. 26557), where Bed 17, the Drumcliff Member of the Choptank Formation, is well-exposed. The taxon is common in the St. Marys Formation in the Little Cove Point and Windmill Point beds. This species is not known stratigraphically higher than the St. Marys.

Type information.—Type material: Holotype and paratypes, ANSP 14305 (Richards, 1968). Type locality: "Patuxent River, St. Mary's Co., Md." (Conrad, 1840).

Figured specimen.—Specimen (USNM 405328) from below Little Cove Point, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—Choptank Formation, Drumcliff Member (middle middle Miocene) in Maryland; St. Marys Formation, Little Cove Point (lower upper Miocene) in Maryland and Windmill Point beds (lower upper Miocene) in Maryland and Virginia.

Busycon spiniger onslowensis Kellum, 1926
Plate 26, figure 2

Busycon spiniger var. *onslowensis* Kellum, 1926, p. 40, Pl. XI, figs. 1–3.
Busycon spiniger onslowensis Kellum. Richards, 1943, p. 525.
Busycon spiniger onslowensis Kellum. Richards, 1950, p. 77, fig. 67f.

Discussion.—This early form of the genus is abundant in the Haywood Landing Member of the Belgrade Formation. It is wider than the more spinose *Busycon spiniger* from the Vicksburgian Stage (lower Oligocene).

Type information.—Holotype: USNM 353254. Type locality: Silverdale, Onslow County, N.C.

Figured specimen.—Specimen (USNM 405329) from the Martin Marietta Company Quarry, Belgrade, Onslow County, N.C. (locality 29).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Genus *Busycotypus* Wenz, 1943

Busycotypus coronatum (Conrad, 1841)
Plate 4, figure 7; Plate 10, figure 3; Plate 13, figure 8

Fulgur coronatus Conrad, 1841, p. 4 of cover. [on back page of cover]. [Date according to Dall, 1893; see Conrad, 1840].
Fulgur coronatum Conrad. Conrad, 1854, p. 317. [Conrad said pub. in 1839].
Busycon coronatum Conrad. Conrad, 1861, p. 82, Pl. XLVI, fig. 1. [Conrad said pub. in 1840].
Busycon coronatum Conrad. Conrad, 1863*b*, p. 560.
Sycotypus coronatus Conrad. Gill, 1867, p. 149.
Sycotypus coronatus Conrad. Conrad, 1868, p. 267, Pl. 24, fig. 1.
Fulgur coronatum Conrad. Heilprin, 1886, p. 108.
Fulgur coronatum Conrad. Martin, 1904, p. 180–181, Pl. XLVI, figs. 1a, 1b.

Fulgur coronatum Conrad. Smith, 1915, Pl. XXIV, figs. 1, 1a.
Busycon coronatum (Conrad). Smith, 1945, p. 247, Pl. 22, figs. 15, 16.
Busycon coronatum (Conrad). Vokes, 1957, p. 33, Pl. 3, fig. 2; Pl. 27, fig. 1.
Busycotypus coronatum (Conrad). Petuch, 1988c, p. 4, (no fig. no.); p. 30, Pl. 4, figs. 1–3. [Issue date 12/15/88].

Discussion.—*Busycotypus coronatum* (Conrad) is a large spinose relative of the concurrent taxon *B. rugosum* (Conrad, 1843). *Busycotypus coronatum* first is differentiated from the parent stock (*B. rugosum*) in the Little Cove Point beds of the St. Marys Formation. It becomes larger and more delicately spinose in the Windmill Point beds of that unit. There is no record of the species in the Claremont Manor Member of the Eastover Formation, which apparently represents appreciably cooler conditions, but the taxon reappears in the warm-temperate to subtropical conditions represented by the Cobham Bay Member. The species is not known higher in the section than the Eastover Formation.

Type information.—Holotype: ANSP 1633 (Richards, 1968). Type locality: "St. Mary's River, Maryland" (Conrad, 1840).

Figured specimen.—Plate 3, figure 9: Specimen (USNM 405330) from 2.7 km below Bowlers Wharf, Essex County, Va. (locality 2). Plate 10, figure 3: Specimen (USNM 405331) from above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12). Plate 13, figure 8: Specimen (USNM 405332) from below Little Cove Point on the western shore of the Chesapeake Bay, Calvert county, Md. (locality 15).

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland and Windmill Point beds (lower upper Miocene) in Maryland and Virginia. Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Busycotypus rugosum (Conrad, 1843)
Plate 10, figure 4; Plate 13, figure 10

Fulgur rugosus Conrad, 1843*a*, p. 307–308.
Fulgur rugosum Conrad. Conrad, 1854, p. 317.
Busycon rugosum Conrad. Conrad, 1861, p. 82–83, Pl. 46, fig. 4.
Busycon rugosum Conrad. Conrad, 1863*b*, p. 561.
Sycotypus rugosus Conrad. Gill, 1867, p. 149.
Sycotypus rugosus Conrad. Conrad, 1868, p. 267, Pl. 24, fig. 4.
Fulgur coronatum var. *rugosum* Conrad. Martin, 1904, p. 181–182, Pl. XLVI, figs. 2a, 2b.
Fulgur rugosum Conrad. Smith, 1915, Pl. XXIV, figs. 2, 2a.
Busycon rugosum (Conrad). Smith, 1945, p. 247, Pl. 22, figs. 15, 16.
Busycon coronatum var. *rugosum* (Conrad). Vokes, 1957, p. 33, Pl. 27, fig. 2.
Busycotypus rugosum (Conrad). Petuch, 1988c, p. 30, Pl. 4, figs. 4–6. [Issue date 12/15/88].
Busycotypus chesapeakensis Petuch, 1988c, p. 41, Pl. 7, figs. 3, 4. [Issue date 12/15/88].
Busycotypus asheri Petuch, 1988c, p. 24, Pl. 4, figs. 9–11. [Issue date 12/15/88].

Discussion.—*Busycotypus rugosum* (Conrad), though clearly related to *B. coronatum* (Conrad), can be distinguished by its obtusely rounded tubercles and stronger spiral striae. *Busycotypus rugosum* is first known to appear in Bed 10 of the Plum Point Marl Member of the Calvert Formation and is common in the Choptank and St. Marys Formations. It is not known higher than the St. Marys but is replaced by an unnamed species in the Cobham Bay Member of the Eastover Formation. The *B. rugosum* lineage is continuously represented in the Miocene, Pliocene, and Pleistocene and is today represented by *B. canaliculatus* (Linné, 1758).

Type information.—The type material was not reported to be among Conrad's types at the Academy of Natural Sciences of Philadelphia (Richards, 1968). I herein designate the figured specimen (Plate 10, fig. 4), a topotype, as neotype (USNM 405333). Type locality: "St. Mary's River, Md." (Conrad, 1843*a*, p. 307). The neotype was found above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12), by Thor Hansen, then a student at George Washington University.

Figured specimen.—Plate 10, figure 4: Neotype (USNM 405333). Plate 13, figure 10: Specimen (USNM 405334) from below Little Cove Point, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—Calvert, Choptank, and St. Marys Formations (lower to lower upper Miocene) in Maryland.

Family NASSARIIDAE Iredale, 1916
Genus *Nassarius* Dumeril, 1806
Subgenus *Tritiaria* Conrad, 1865

Nassarius (*Tritiaria*) *peralta* (Conrad, 1868)
Plate 9, figure 3

Nassa trivittata Say. Conrad, 1830, p. 211. [Not *N. trivittata* of Say, 1822].

Ptychosalpinx (*Tritiaria*) *peralta* Conrad, 1868, p. 264, Pl. 19, fig. 5.
Nassa peralta (Conrad). Martin, 1904, p. 195, Pl. XLIX, figs. 9, 10.
Nassarius peralta (Conrad). Richards, 1947, p. 29, Pl. 11, figs. 7, 11.
Uzita peralta (Conrad). Gardner, 1948*a*, p. 116, Pl. 1, figs. 25, 26.
Nassarius peralta (Conrad). Vokes, 1957, p. 32, Pl. 24, fig. 17.
Hinia (*Amyclina?*) *peralta* Conrad. Glibert, 1963, p. 113.

Discussion.—*Nassarius peralta* is a small form that is present in the Little Cove Point and Windmill Point beds of the St. Marys Formation, and in many instances, in countless numbers. In both members the taxon is size-sorted and concentrated in thin beds.

Type information.—Type: Richards (1968) does not list *Nassarius* (*Tritiaria*) *peralta* among Conrad's types at the Academy of Natural Sciences of Philadelphia. I herein designate the figured specimen (USNM 405335, Pl. 9, fig. 3), a probable topotype, as the neotype. Type locality: Conrad (1868) listed no locality. Because of the abundance of the form in the St. Marys Formation, it is probable that it came from the St. Marys River, St. Marys County, Md. He collected specimens of the taxon at that locality (Conrad, 1830, p. 211) that he originally identified as "*Nassa trivittata* Say."

Figured specimen.—Neotype (USNM 405335), from above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12).

Stratigraphic and geographic range.—St. Marys Formation (lower upper Miocene) in Maryland and Virginia.

Genus *Bulliopsis* Conrad, 1863

Bulliopsis quadrata (Conrad, 1830)
Plate 4, figure 9

Nassa quadrata Conrad, 1830, p. 211, 226, Pl. IX, fig. 16.
Buccinum quadratum Conrad. Conrad, 1842*b*, p. 187.
Bullia (*Bulliopsis*) *quadrata* Conrad. Conrad, 1863*a*, p. 287.
Tritia (*Bulliopsis*) *quadrata* Conrad. Conrad, 1863*b*, p. 563.
Nassa (*Bulliopsis*) *quadrata* Conrad. Conrad, 1866, p. 65, Pl. III, fig. 1.
Nassa (*Bulliopsis*) *subcylindrica* Conrad, 1866, p. 66.
Melanopsis quadrata Conrad. Conrad, 1868, p. 259.
Bulliopsis quadrata Conrad. Martin, 1904, p. 198, Pl. L, fig. 3.
Melanopsis quadrata Conrad. Richards, 1947, p. 28, Pl. 11, fig. 6.
Bulliopsis quadrata (Conrad). Gardner, 1948*a*, p. 116, Pl. 1, figs. 17, 27.
Bulliopsis quadrata (Conrad). Vokes, 1957, p. 32, Pl. 24, fig. 13.
Bulliopsis quadrata Conrad. Glibert, 1963, p. 99.
Bulliopsis quadrata (Conrad). Petuch, 1988*c*, p. 18, Pl. 1, figs. 1, 2.

Discussion.—*Bulliopsis quadrata* is common in the Windmill Point beds of the St. Marys Formation. It is not known from the cool-temperate assemblages of the Claremont Manor Member of the Eastover Formation, but reappears in the Cobham Bay Member. The taxon is not known lower than the St. Marys or higher than the Eastover.

Type information.—Conrad's type material is reported by Moore (1962) and Richards (1968) to be in the Academy of Natural Sciences of Philadelphia (ANSP 15686). Type locality: "St. Mary's River" (Conrad, 1830, p. 210), St. Marys County, Md.

Figured specimen.—Specimen (USNM 405336) from 2.7 km below Bowlers Wharf, Essex County, Va. (locality 2).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland and Virginia. Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Bulliopsis marylandica (Conrad, 1863)
Plate 13, figure 3

Bullia (*Bulliopsis*) *marylandica* Conrad, 1863*a*, p. 287.
Tritia (*Bulliopsis*) *marylandica* Conrad. Conrad, 1863*b*, p. 562.
Nassa (*Bulliopsis*) *marylandica* Conrad. Conrad, 1866, p. 65, Pl. III, fig. 3.
Melanopsis marylandica Conrad. Conrad, 1868, p. 259.
Bulliopsis marylandica Conrad. Martin, 1904, p. 198–199, Pl. L, fig. 4.
Bulliopsis marylandica Conrad. Vokes, 1957, p. 32, Pl. 24, fig. 14.
Bulliopsis marylandica (Conrd). Petuch, 1988*c*, p. 42, Pl. 7, fig. 9.

Discussion.—*Bulliopsis marylandica* (Conrad) is common but never abundant in the St. Marys Formation, and it is not known higher or lower than that unit.

Type information.—*Bulliopsis marylandica* is not listed by Richards (1968) as being in Conrad's types at the Academy of Natural Sciences of Philadelphia. I herein designate the figured specimen (USNM 405337, Pl. 13, fig. 3) as neotype. Type locality: "St. Mary's Co., Md." (Conrad, 1863*a*, p. 287).

Figured specimen.—Neotype (USNM 405337) from below Little Cove Point, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point and Windmill Point beds (lower upper Miocene) in Maryland.

Family FASCIOLARIIDAE Gray, 1853
Subfamily FUSININAE Swainson, 1840
Genus *Fusinus* Rafinesque, 1815

Fusinus hoffmani, new species
Plate 26, figure 1

Diagnosis.—Shell small, moderately thick, fusiform, siphonostomatous, non-umbilicate, with numerous, very fine spiral threads and moderately long, siphonal notch.

Description.—Shell small, moderately thick, fusiform, siphonostomatous, with a moderately long siphonal notch. Whorls broadly rounded with only a slight manifestation of a keel in the upper one-fifth of the body whorl, above which is a nearly flat sutural ramp. Sutures are well-impressed, becoming more so in later stages. Ornamentation consists of numerous, very fine spiral striae, which are alternately thin, then slightly thicker. This pattern is very regular over most of the body whorl but is somewhat irregular on the sutural ramp. Lower part of the body whorl tapers sharply to a somewhat constricted and anteriorly produced columella. Columella is non-umbilicate with a tightly coiled, smooth, siphonal fasciole. Aperture is siphonostomatous, suboval in outline, somewhat sharply angular posteriorly. Parietal callus weakly defined. Interior of outer lip marked by numerous, elongate, raised denticles, which are obscured further into the aperture. Columella neck moderately long but short for the genus with a deep, wide siphonal notch.

The holotype (USNM 405338) is 51.7 mm in height, and 23.2 mm wide.

Discussion.—*Fusinus hoffmani*, new species, is unusually short and wide for the genus and lacks the axial ribbing common to the taxon, but otherwise is typical. The species is common in the Haywood Landing Member of the Belgrade Formation in North Carolina and is not known from any other unit. The species is named for C. W. Hoffman of the North Carolina Geological Survey.

Type information.—Holotype: USNM 405338. Type locality: Silverdale Marl Company Quarry, Silverdale, Onslow County, N.C. (locality 30).

Figured specimen.—Holotype (USNM 405338).

Stratigraphic and geographic range.—Belgrade Formation, Haywood Landing Member (upper Oligocene and lower Miocene) in North Carolina.

Genus *Buccinofusus* Conrad, 1868

Buccinofusus chesapeakensis Petuch, 1988
Plate 13, figure 7

Buccinofusus chesapeakensis Petuch, 1988c, p. 41, Pl. 7, figs. 14, 15. [Issue date 12/15/88].

Discussion.—*Buccinofusus chesapeakensis* is the precursor to the upper St. Marys form, *B. parilis* (Conrad). It differs from that species by being stouter and by possessing stronger axial ribs. *Buccinofusus chesapeakensis* is known only from the Little Cove Point beds of the St. Marys Formation.

Type information.—Holotype: USNM 427962. Paratype: Florida Atlantic University collection—no number assigned. Type locality: "Little Cove Point, Calvert County, Maryland."

Figured specimen.—Plate 13, figure 7: USNM 405340, from below Little Cove Point, on the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland.

Buccinofusus parilis (Conrad, 1832)
Plate 9, figure 5

Fusus parilis Conrad, 1832, p. 18, Pl. 4, fig. 2.
Fusus parilis Conrad. Conrad, 1842*b*, p. 183, 187. [Not p. 185].
Fusus parilis Conrad. Conrad, 1861, p. 85, Pl. XLIX, fig. 5.
Neptunea parilis Conrad, 1863*b*, p. 560.
Buccinofusus parilis Conrad. Conrad, 1868, p. 264.
Buccinofusus parilis Conrad. Tryon, 1881, p. 47, Pl. XXVIII, fig. 40.
Buccinofusus parilis Conrad. Cossman, 1901, p. 33, Pl. 1, fig. 10.
Buccinofusus parilis Conrad. Martin, 1904, p. 184–185, Pl. XLVII, fig. 4.
Buccinofusus parilis (Conrad). Vokes, 1957, p. 33, Pl. 26, fig. 3.
Buccinofusus parilis (Conrad). Petuch, 1988c, p. 42, Pl. 7, figs. 12, 13.
Buccinofusus parilis (Conrad). Ward and Powars, 1989, p. 37, Pl. 11, fig. 5.

Discussion.—This large, high-spired species is common in the Windmill Point beds of the St. Marys Formation. The Little Cove Point species, *B. chesapeakensis*, is slightly stouter with somewhat more

robust axial ribs, but otherwise the two forms are very similar. *Buccinofusus parilis* seems to be related to *Siphonalia devexa* (Conrad, 1842), which occurs in the Calvert and Choptank Formations. Neither *Buccinofusus parilis* nor the genus *Buccinofusus* are known stratigraphically higher than the St. Marys.

Type information.—Type: Moore (1962) and Richards (1968) reported that the holotype and paratypes were at the Academy of Natural Sciences of Philadelphia (ANSP 13842). Type locality: "St. Mary's River, Md." (Conrad, 1832, p. 19).

Figured specimen.—Plate 9, figure 5: USNM 405339, from above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds in Maryland and Virginia (lower upper Miocene).

Superfamily VOLUTOIDEA Rafinesque, 1815
Family OLIVIDAE Latreille, 1825
Subfamily OLIVINAE Swainson, 1840
Genus *Oliva* Bruguière, 1789

Oliva idonea Conrad, 1839
Plate 4, figure 5

Oliva idonea Conrad, 1839, description only inside back cover.
Dactylus (*Strephona*) *idonea* Conrad. Conrad, 1863*b*, p. 563.
Dactylus idoneus Conrad. Conrad, 1868, p. 261, Pl. 22, fig. 1.
Oliva idonea Conrad. Gardner, 1948*b*, p. 258, Pl. 38, figs. 1, 3.

Discussion.—*Oliva idonea* Conrad is a large, ovate, thick-shelled form that is common to abundant in some areas of the Cobham Bay basin. The only species of *Oliva* known from the Chesapeake Group stratigraphically lower than *Oliva idonea* is a very small species (*Oliva harrisi* Martin, 1904) in Bed 10 of the Plum Point Marl Member of the Calvert Formation which bears little resemblance to this form, and an unnamed species from Church Hill, Md. *Oliva canaliculata* H. C. Lea succeeds *O. idonea* in the Yorktown Formation but is a distinct form, much less robust, thinner, less rounded, smaller, and not closely related to the species in the Cobham Bay Member of the Eastover Formation.

Type information.—Type material is listed by Richards (1968) as being in the Academy of Natural Sciences of Philadelphia (ANSP 1613). The holotype(?) was figured by Gardner (1948*b*, Pl. 38, figs. 1, 8). Type locality: "Near Urbanna, Virg." (Conrad, 1839).

Figured specimen.—Specimen (USNM 405341) from Union Mill, Richmond County, Va.

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Family VOLUTIDAE Rafinesque, 1815
Subfamily SCAPHELLINAE H. Adams and A. Adams, 1858
Genus *Scaphella* Swainson, 1832

Scaphella virginiana Dall, 1890
Plate 19, figure 9

Voluta mutabilis Conrad. Conrad, 1842*b*, p. 182. [List only].
Scaphella (*Aurinia*) *virginiana* Dall, 1890, p. 80.
Scaphella (*Aurinia*) *virginiana* Dall. Dall, 1892, p. 227–228.
Scaphella typus Conrad. Harris, 1893, p. 24. [List only].
Scaphella (*Aurinia*) *typus* (Conrad). Martin, 1904, p. 175, Pl. XLIV, fig. 10.
Scaphella (*Aurinia*) *conradiana* Martin, 1904, p. 175.
Aurinia typus (Conrad). Vokes, 1957, p. 47, Pl. 27, fig. 4.
Volutifusus choptankensis Petuch, 1988*d*, p. 77, Pl. 2, figs. 5, 6.
Volutifusus caricelloides Petuch, 1988*d*, p. 77, Pl. 2, figs. 9, 10.
Scaphella virginiana Dall. Ward and Powars, 1989, p. 35, Pl. 9, fig. 9.
Not—
Fasciolaria mutabilis Conrad, 1834, p. 135.
Volutifusus typus Conrad, 1866, p. 67, Pl. 3, fig. 2.

Discussion.—The origin of the name *virginiana* for this taxon is confusing but seems to be proper. Dall (1892) believed that the specimens given him by Harris and Willcox from Maryland were the same species as that named *Volutifusus typus* by Conrad from North Carolina. The North Carolina fossil was validly named *V. typus* by Conrad (1866) and is not the same species as that from the Calvert and Choptank Formations in Maryland. Dall (1890, 1892) took exception to Conrad's (1866) name "*typus*" and suggested the use of another manuscript name of Conrad's, "*virginiana*." The specimens described by Dall (1892, p. 227–228) were from a suite of specimens from Maryland, and his application of the name *Scaphella* (*Aurinia*) *virginiana* to that taxon constitutes a valid naming of that species. Conrad probably did not intend to use the name "*virginiana*" for the Maryland form, but he never published the name, thus leaving it available to Dall. Martin (1904) took exception to Dall's (1890, 1892) rejection of the name "*typus*" and believed that "*virginiana*" would be a misleading name. He proposed the use of "*conradi-*

ana." That name is a junior synonym of *S.* (*A.*) *virginiana* Dall, 1890.

Type information.—Neotype: USNM 405342. Dall's (1892) material could not be located among his types at the National Museum of Natural History. I herein designate the figured specimen (USNM 405342) (Pl. 19, fig. 9) as neotype. That specimen is a probable topotype. Type locality: "Older Miocene of Plum Point and the Patuxent River, Maryland" (Dall, 1892, p. 227). Dall's specimens probably came from Drumcliff, right bank of the Patuxent River, St. Marys County, Md. (same as locality 16 of this report).

Figured specimen.—Neotype (USNM 405342) from Drumcliff, on the Patuxent River, St. Marys County, Md. (locality 16).

Stratigraphic and geographic range.—Calvert Formation, Plum Point Marl Member, Bed 10 (lower middle Miocene) in Maryland. Choptank Formation, Drumcliff Member (middle middle Miocene) in Maryland.

Superfamily CONOIDEA Rafinesque, 1815
Family CONIDAE Rafinesque, 1815
Genus *Conus* Linné, 1758

Conus deluvianus Green, 1830
Plate 9, figure 1

Conus deluvianus Green, 1830, p. 124.
Conus diluvianus Green. Conrad, 1863*b*, p. 566.
Conus diluvianus Green. Martin, 1904, p. 145–146, Pl. XL, figs. 15–17.
Conus diluvianus Green. Smith, 1931, p. 283, fig. 5, 6; p. 285, fig. 8.
Conus diluvianus Green. Smith, 1945, Pl. 21, figs. 12, 13.
Conus diluvianus Green. Vokes, 1957, p. 35, Pl. 28, fig. 13.
Conus diluvianus Green. Petuch, 1988*c*, p. 28, Pl. 3, figs. 18, 19; p. 36, Pl. 6, fig. 23. [Issue date 12/15/88].
Conus (Leptoconus) sanctaemariae Petuch, 1988*c*, p. 34, Pl. 3, figs. 20, 21; Pl. 6, fig. 24. [Issue date 12/15/88].
Conus (Leptoconus) diluvianus Green. Petuch, 1988*d*, Pl. 2, figs. 13, 14. [Issue date 1/12/89].
Conus (Leptoconus) sp. Petuch, 1988*d*, Pl. 2, fig. 12.
Conus (Leptoconus) asheri Petuch, 1988*d*, p. 77–79, Pl. 2, figs. 15, 16. [Issue date 1/12/89].
Conus deluvianus Green. Ward and Powars, 1989, p. 37, Pl. 11, fig. 1.
Not—
Conus diluvianus Green. Tuomey and Holmes, 1856, p. 132, Pl. XXVII, fig. 15.
Conus diluvianus Green. Emmons, 1858, p. 263–264, fig. 143.

Discussion.—*Conus deluvianus* was named by Green (1830) for material given him by Conrad from "St. Mary's, in Maryland." In the same publication Green named *C. marylandicus* for material given him by Finch, supposedly from the same locality. *Conus marylandicus* was collected from the Yorktown Formation at Yorktown, Va., and does not occur in the St. Marys Formation or in Maryland. See the discussion on *Rasia arata* (Say) and Ward and Blackwelder (1975) for an account of this confusion. *Conus deluvianus* is a much larger species than *C. marylandicus* and is thicker and more elongate. *Conus deluvianus* is known only from the Windmill Point beds of the St. Marys Formation. Green (1930) did not figure *C. deluvianus*, but the large form described by him is common in the Windmill Point beds on the St. Marys River.

Type information.—The whereabouts of the type material is unknown. I herein designate the figured specimen (USNM 405343; Pl. 9, fig. 1), a topotype, be used as the neotype. Type locality: "St. Mary's, Maryland" (Green, 1830, p. 124). The neotype comes from above Windmill Point, St. Marys River, St. Marys County, Md. (locality 12) and was found by Thor Hansen, then a student at George Washington University.

Figured specimen.—Neotype (USNM 405343).

Stratigraphic and geographic range.—St. Marys Formation, Windmill Point beds (lower upper Miocene) in Maryland and Virginia.

Conus spenceri, new species
Plate 4, figure 6

Diagnosis.—Shell small, thin, slender, biconical, with a long, narrow aperture and spiral striae on the lower half of the body whorl.

Description.—Shell small, thin, slender, strongly biconical. Spire elevated, somewhat turbinate, with a sharply angular shoulder demarking a slightly concave sutural ramp. Suture only slightly impressed. Sculpture consists of 14 very small spiral folds on the lower half of the body whorl. A small parietal ridge is apparent just below the suture within the aperture. Aperture (broken in the holotype) is elongate, slender, siphonstomatous. The holotype (USNM 405344) is 35.9 mm in height and 16.1 mm in width.

Discussion.—*Conus spenceri* is smaller and higher spired form than that from the St. Marys Formation, *C. deluvianus* Green, 1830, it is much thinner-shelled

and narrower, and its spiral threads are more distinct. The spire on C. *deluvianus* is almost smoothly conical, whereas on C. *spenceri* it is somewhat turbinate. *Conus spenceri* differs from C. *marylandicus* Green, 1830 from the Yorktown Formation of Virginia in being more slender and higher spired.

Type information.—Holotype: USNM 405344. Type locality: Just below the mouth of Whiting Creek, right bank of the Rappahannock River, Middlesex County, Va. (USGS locality 26061).

Figured specimen.—Holotype (USNM 405344).

Stratigraphic and geographic range.—Eastover Formation, Cobham Bay Member (upper Miocene) in Virginia.

Family TEREBRIDAE H. Adams and A. Adams, 1854
Genus *Terebra* Bruguière, 1789

Terebra simplex Conrad, 1830
Plate 13, figure 6

Terebra simplex Conrad, 1830, p. 226, Pl. IX, fig. 22.
Terebra (Acus) simplex Conrad. Conrad, 1863*b*, p. 565.
Terebra (Acus) sublirata Conrad, 1863*b*, p. 563 [*nomen nudem*].
Terebra simplex Conrad. Conrad, 1868, p. 68, Pl. 3, fig. 5.
Terebra (Hastula) simplex Conrad. Martin, 1904, p. 143, Pl. XL, fig. 10.
Terebra simplex var. *sublirata* Conrad. Martin, 1904, p. 144, Pl. XL, fig. 11.
Terebra simplex Conrad. Richards, 1947, p. 29, Pl. 11, fig. 5.
Terebra simplex Conrad. Gardner, 1948*a*, p. 116, Pl. 1, fig. 16.
Terebra simplex Conrad. Vokes, 1957, p. 35, Pl. 28, fig. 10.
Terebra simplex var. *sublirata* Dall. Vokes, 1957, p. 35, Pl. 28, fig. 9.
Terebra chancellorensis Oleksyshyn, 1960, p. 103–104, figs. 3, 4.

Discussion.—*Terebra simplex* is somewhat variable in form, spiral angle, and exterior sculpture. It typically lacks spiral and axial ornamentation, though the latter is sometimes expressed as fine, slightly sinuous, incremental lines. This form was assigned to *T. simplex* var. *sublirata* by Glenn (1904), using a *nomen nudem* of Conrad (1863*b*). I believe that Glenn's specimens fall well within the limits of variability of *T. simplex*. *Terebra chancellorensis* Oleksyshyn (1960) also appears to be a junior synonym of *T. simplex*. *Terebra simplex* is common to abundant in the Little Cove Point and Windmill Point beds of the St. Marys Formation. It is not known to occur above or below the St. Marys Formation.

Type information.—Type: ANSP 15698. Type locality: "The beds at St. Mary's River" (Conrad, 1830, p. 210) [St. Marys County, Md.].

Figured specimen.—Specimen (USNM 405345) from below Little Cove Point, on the western shore of the Chesapeake Bay, Calvert County, Md. (locality 15).

Stratigraphic and geographic range.—St. Marys Formation, Little Cove Point beds (lower upper Miocene) in Maryland and Windmill Point beds (lower upper Miocene) in Maryland and Virginia.

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APPENDIX
LOCALITY REGISTER

U.S. Geological Survey, Washington, D.C., Tertiary Paleontology Register

(USGS)

26027 1. Laytons Landing, 0.6 km below the mouth of Layton Branch, right bank of the Rappahannock River, Essex Co., Va. Morattico 7.5 min. quadrangle.

26026 2. 1.7 km below Bowlers Wharf, right bank of the Rappahannock River, Essex Co., Va. Morattico 7.5 min. quadrangle.

26052 3. 0.8 km below Cobham Wharf, right bank of the James River, Surry Co., Va. Surry 7.5 min. quadrangle.

26025 4. 0.8 km above Mount Pleasant, right bank of the James River, Surry Co., Va. Surry 7.5 min. quadrangle.

26551 5. 0.8 km above the mouth of Bush Park Creek, right bank of the Rappahannock River, Middlesex Co., Va. Wilton 7.5 min. quadrangle.

26053 6. 2.0 km north of the Murfreesboro town limits, right bank of the Meherrin River, Hertford Co., N.C. Murfreesboro 7.5 min. quadrangle.

26066 7. 1.3 km below the mouth of Sunken Meadow Creek, right bank of the James River, Surry Co., Va. Claremont 7.5 min. quadrangle.

26046 8. White Oak Landing, right bank of the Mattaponi River, King William Co., Va. King and Queen Court House 7.5 min. quadrangle.

26035 9. Rickahock, left bank of the Mattaponi River, King and Queen Co., Va. King and Queen Court House 7.5 min. quadrangle.

26036 10. Elsing Green, left bank of the Pamunkey River, King William Co., Va. Tunstall 7.5 min. quadrangle.

26092 11. Mt. Airy Mill Pond, just off Rte. 621, Richmond Co., Va. Tappahannock 7.5 min. quadrangle.

26554 12. 0.5 km above Windmill Point, right bank of the St. Marys River, St. Marys Co., Md. (=USGS 25304). St. Marys City 7.5 quadrangle.

26555 13. 0.4 km below Chancellor Point, left bank of the St. Marys River, St. Marys Co., Md. St. Marys City 7.5 min. quadrangle.

26091 14. Essex Mill, 2.2 km west of Dunnsville, Essex Co., Va. Dunnsville 7.5 min. quadrangle.

26556 15. 1.0 km below Little Cove Point, western shore of the Chesapeake Bay, Calvert Co., Md. Solomons Island 7.5 min. quadrangle.

26557 16. Drumcliff (Jones Wharf in old literature), 1.0 km above the mouth of Saint Thomas Creek, right bank of the Patuxent River, St. Marys Co., Md. Broomes Island 7.5 min. quadrangle.

26558 17. 1.8 km SE of Flag Ponds and 0.6 km NW of the Baltimore Gas and Electric Power Plant, western shore of the Chesapeake Bay, Calvert Co., Md. Cove Point 7.5 min. quadrangle.

26559 18. 1.0 km south of the mouth of Parker Creek, just north of the community of Scientists Cliffs, western shore of the Chesapeake Bay, Calvert Co., Md. Prince Frederick 7.5 min. quadrangle.

26560 19. 0.72 km above Portobello Point, at Orchard Point, right bank of the St. Marys River, St. Marys Co., Md. St. Marys City 7.5 min. quadrangle.

26561 20. 1.3 km above Islington Landing, 1.0 km below the mouth of Little Carter Creek, Richmond Co., Va. Tappahannock 7.5 min. quadrangle.

26562 21. 0.7 km above the mouth of Hellen Creek, left bank of Patuxent River, Calvert Co., Md. Solomons Island 7.5 min. quadrangle.

26563 22. Langleys Bluff (of old literature), 7.3 km below Cedar Point, 1.0 km below the mouth of Beaver Dam Creek, western shore of the Chesapeake Bay, St. Marys Co., Md. St. Marys City 7.5 min. quadrangle.

26564 23. Queen Tree Landing, just above the mouth of Cat Creek, right bank of the Patuxent River, St. Marys Co., Md. Broomes Island 7.5 min. quadrangle.

26565 24. 3.2 km above Haulover Inlet, right bank of the Potomac River, Westmoreland Co., Va. Stratford 7.5 min. quadrangle.

26566 25. Fones Cliffs, just upriver of Smoots Landing, 3.5 km below Carters Wharf, left bank of the Rappahannock River, Richmond Co., Va. Champlain 7.5 min. quadrangle.

26567 26. Randle Cliff, 1.3 km below Chesapeake Beach, 0.7 km north of Randle Cliff Beach, western shore of the Chesapeake Bay, Calvert, Co., Md. North Beach 7.5 min. quadrangle.

26568 27. 0.4 km above Jones Point, left bank of the Patuxent River, Calvert Co., Md. Lower Marlboro 7.5 min. quadrangle.

26569 28. Haywood Landing, left bank of the White Oak River, 1.2 km below the mouth of Holston Creek, Jones Co., N.C. Maysville 15 min. quadrangle.

26570 29. Martin Marietta Company, Belgrade Quarry, just east of the intersection of Rte. 17 and Rte. 1434 at Belgrade, Onslow Co., N.C. Maysville 15 min. quadrangle.

26571 30. Silverdale Marl Company Quarry at Silverdale, 0.4 km SE of intersection of Rte. 1434 and Rte. 1442, Onslow Co., N.C. Maysville 15 min. quadrangle.

26412 31. Right bank of the Pamunkey River at Horseshoe, Hanover County, Va. Manguin 7.5 min. quadrangle.

26417 32. Warren Brothers sand pits, 2.3 km southeast of Bottoms Bridge, 3.2 km northeast of Elko, Henrico County, Va. Roxbury 7.5 min. quadrangle.

TAXONOMIC INDEX

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PLATES 1 – 26

PLATE 1

Mollusks of the *Costaglycymeris mixoni/Chesapecten jeffersonius* Interval-zone (M-7)

Figure

1. *Striarca centenaria* (Say) (p. 60)
   Right valve (USNM 405191); below Claremont, Surry Co., Va. (loc. 7, USGS loc. 26066); length 27.5 mm, height 18.8 mm.

2, 3. *Costaglycymeris mixoni* Ward, new species (p. 61)
   2. Dorsal view, holotype (USNM 380782); Cobham Wharf, Va. (loc. 3, USGS loc. 26052).
   3. Right valve (USNM 258361); the same locality; length 29.2 mm, height 27.9 mm.

4. *Isognomon* (*Hippochaeta*) sp. (p. 63)
   Right valve, nearly complete specimen (USNM 258364); Burhans Wharf on the Rappahannock River, Middlesex Co., Va. (USGS loc. 26062); length 225.0 mm.

5. *Rasia arata* (Say) (p. 53)
   Right valve (USNM 405183); below Sunken Meadow Creek, Surry Co., Va. (loc. 7, USGS loc. 26066); length 53.3 mm, height 32.2 mm.

6, 8. *Dallarca carolinensis* Dall (p. 55)
   6. Right valve (USNM 258360); 2.7 km below Bowlers Wharf on the Rappahannock River, Va. (loc. 2, USGS 26026); length 44.9 mm, height 46.7 mm.
   8. Left valve (USNM 258360); length 44.8 mm, height 46.8 mm.

7, 9. *Conradostrea greeni* Ward, new species (p. 78)
   7. Exterior, left valve, holotype (USNM 405216); just below the mouth of Whiting Creek, Middlesex Co., Va.; length 24.0 mm, height 26.7 mm.
   9. Interior, same specimen.

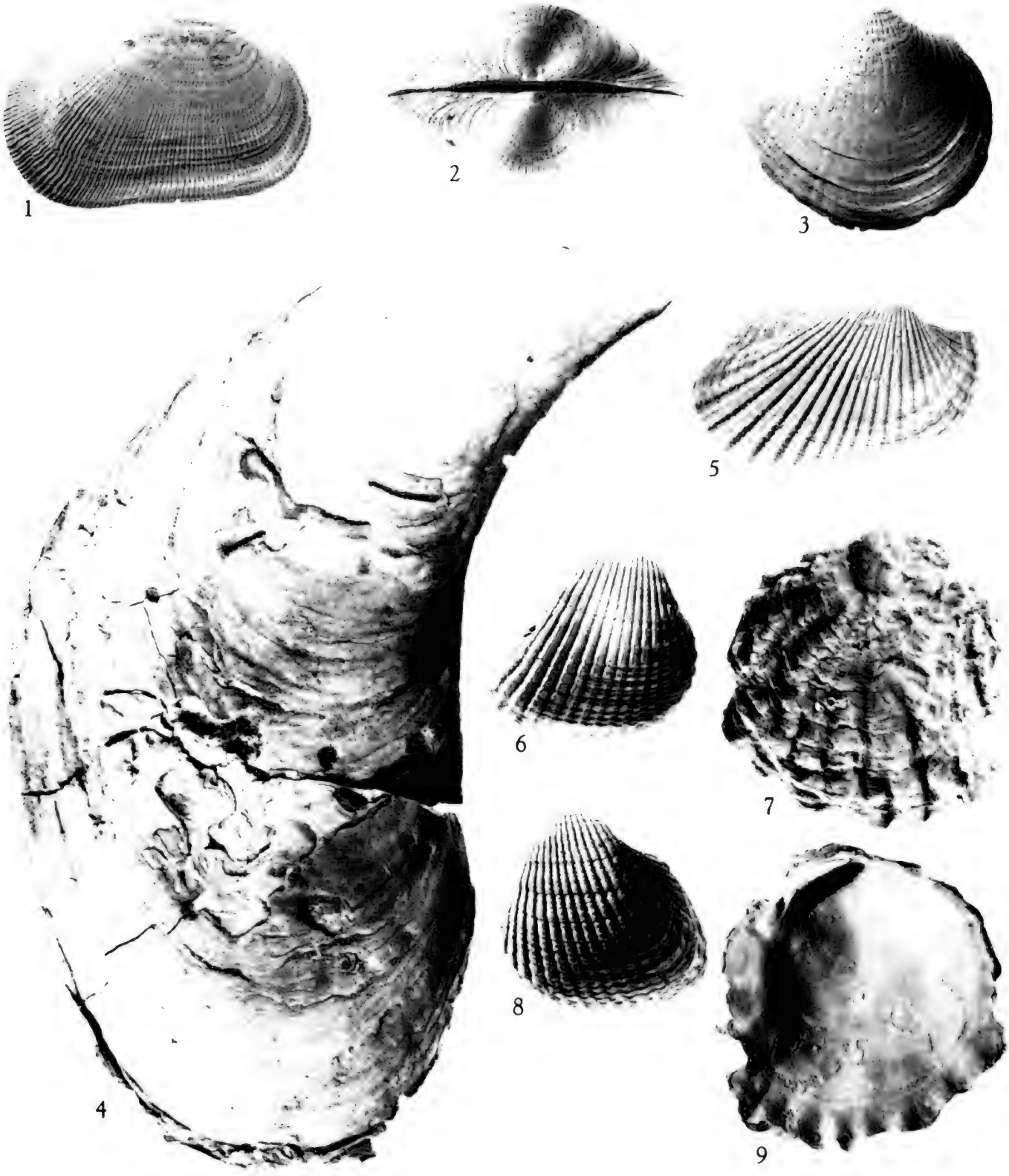
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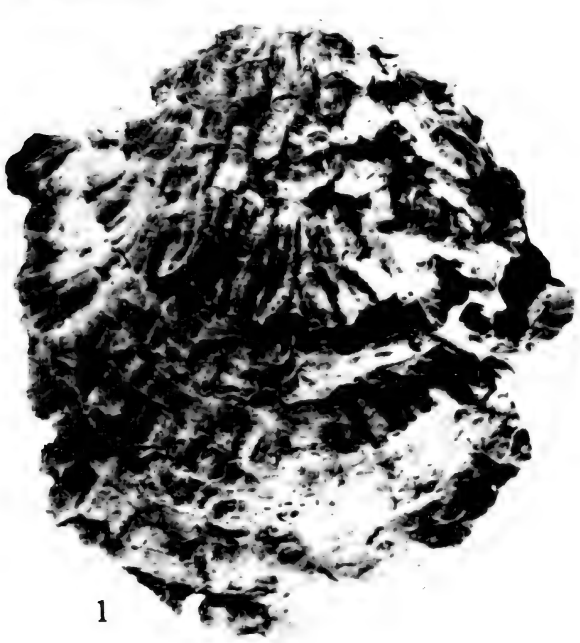
PLATE 2

Mollusks of the *Costaglycymeris mixoni/Chesapecten jeffersonius* Interval-zone (M-7)

Figure

1. *Ostrea compressirostra geraldjohnsoni* Ward, new subspecies (p. 76)
   Holotype (USNM 258370), left valve; Cobham Wharf, Va. (loc. 3, USGS 26052); length 90.1 mm, height 106.8 mm.
2. *Chesapecten (Chesapecten) middlesexensis* (Mansfield) (p. 69)
   Right valve (USNM 258363); Urbanna Creek, Middlesex Co., Va. (USGS loc. 26029); length 115.2 mm, height 110.1 mm.
3. *Placopecten princepoides* (Emmons) (p. 66)
   Right valve, topotype specimen (USNM 258359); just above Murfreesboro, N.C., on the Meherrin River (loc. 6, USGS loc. 26053); length 155.8 mm, height 140.0 mm.
4. *Carolinapecten urbannaensis* (Mansfield) (p. 65)
   Right valve (USNM 258362); Cobham Wharf, Va. (loc. 3, USGS loc. 26052); length 77.3 mm, height 73.5 mm.
5. *Euvola smithi* (Olsson) (p. 66)
   Right valve (USNM 405196); Cobham Wharf, Va. (loc. 3, USGS loc. 26052); length 90.2 mm, height 83.0 mm.



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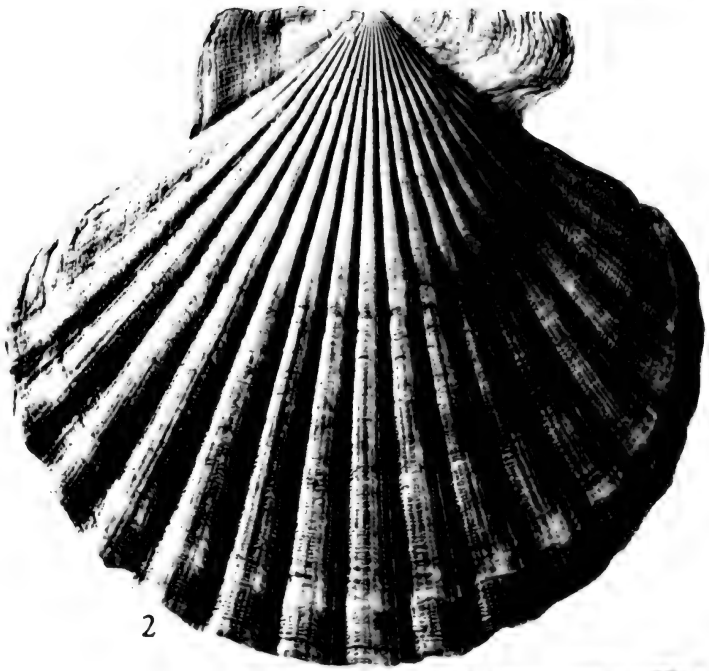

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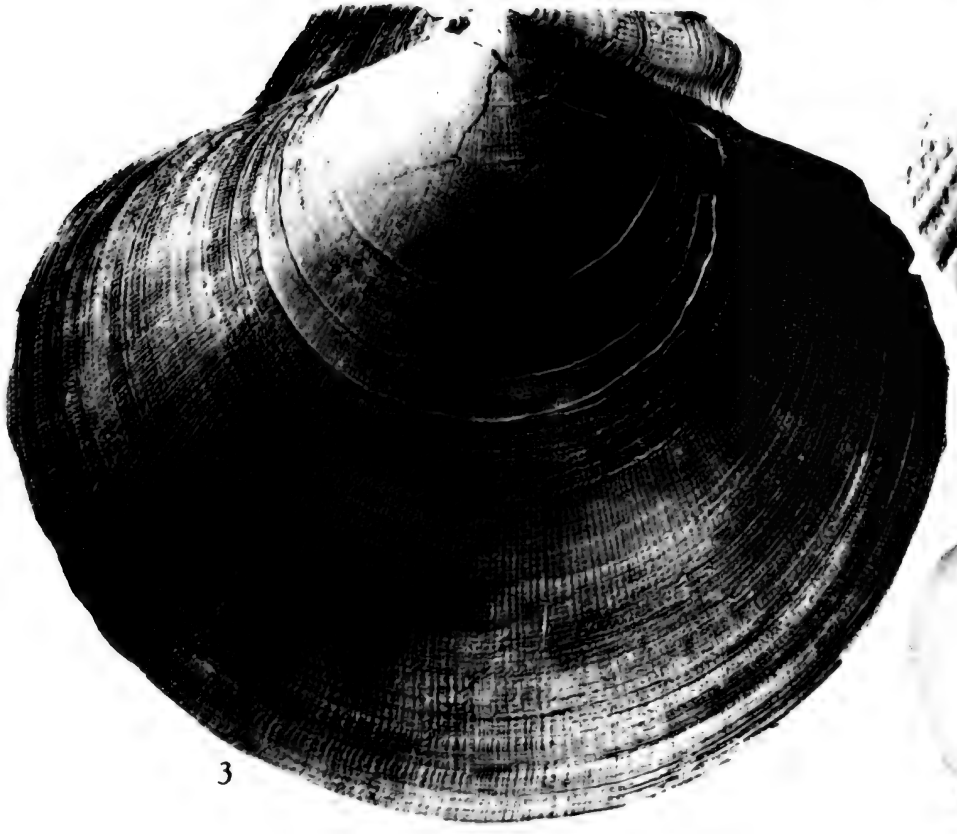

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PLATE 3

Mollusks of the *Costaglycymeris mixoni/Chesapecten jeffersonius* Interval-zone (M-7)

Figure

1. *Astarte cobhamensis* Ward, new species (p. 83)
   Holotype, right valve (USNM 405236); below Cobham Wharf, Surry Co., Va. (loc. 3, USGS loc. 26052); length 14.7 mm, height 15.0 mm.
2. *Marvacrassatella urbannaensis* (Mansfield) (p. 86)
   Right valve (USNM 405247); Urbanna Creek above Urbanna, Middlesex Co., Va.; length 78.0 mm, height 55.0 mm.
3. *Astarte rappahannockensis* (Gardner) (p. 82)
   Left valve (USNM 258265); below Sunken Meadow Creek on the James River, Surry Co., Va. (loc. 7, USGS loc. 26066); length 21.9 mm, height 19.8 mm.
4. *Chesacardium laqueatum blountense* (Mansfield) (p. 90)
   Right valve (USNM 405251); 2.7 km below Bowlers Wharf, Essex Co., Va. (loc. 2, USGS loc. 26026); length 106.9 mm, height 111.7 mm.

5, 6. *"Spisula" rappahannockensis* (Gardner) (p. 95)
   5. Left valve (USNM 258268); 2.7 km below Bowlers Wharf on the Rappahannock River, Va. (loc. 2, USGS loc. 26026); length 27.2 mm, height 18.8 mm.
   6. Interior, right valve (USNM 258369); same locality as fig. 5; length 28.0 mm, height 19.0 mm.

7. *Lirophora vredenburgi* Ward, new species (p. 104)
   Holotype (USNM 405281), right valve; mouth of Whiting Creek, on the Rappahannock River, Middlesex Co., Va.; length 24.7 mm, height 21.7 mm.
8. *Mercenaria druidi* Ward, new name (p. 107)
   Left valve (USNM 258367); Urbanna Creek, just above Urbanna, Middlesex Co., Va. (USGS loc. 26029); length 75.5 mm, height 63.3mm.
9. *Euloxa latisulcata* (Conrad) (p. 96)
   Left valve (USNM 258366); Cobham Wharf, Va. (loc. 3, USGS loc. 26052); length 20.9 mm, height 18.9 mm.


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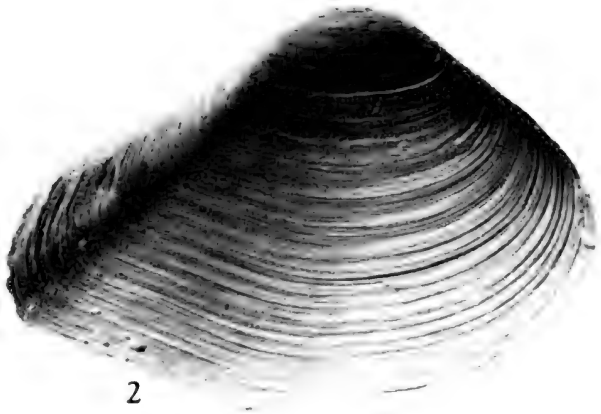
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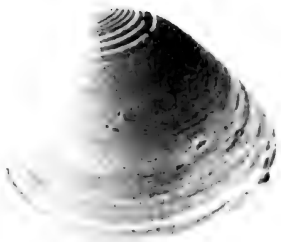
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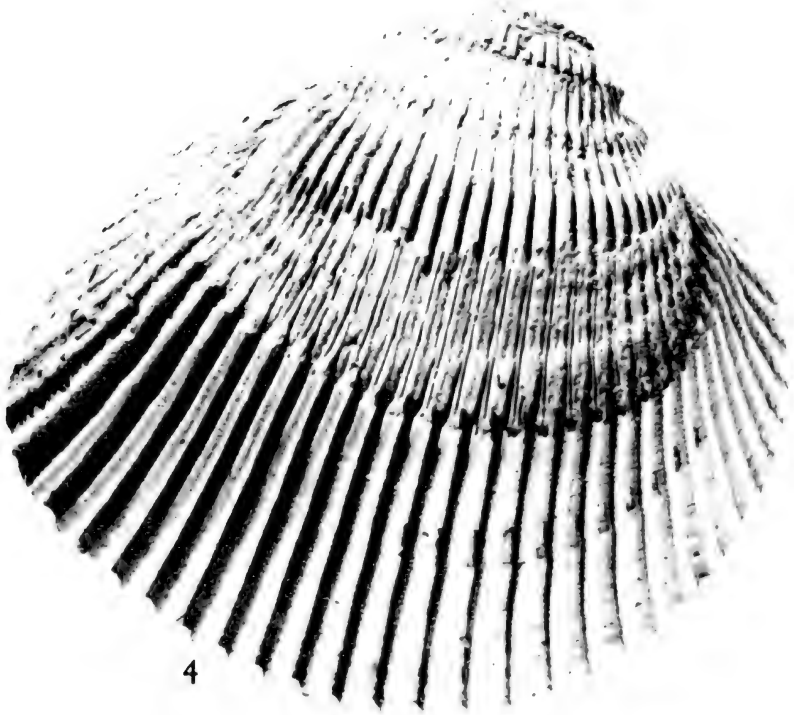
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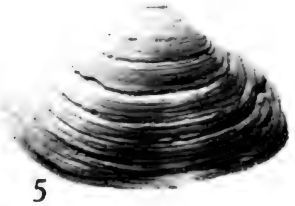
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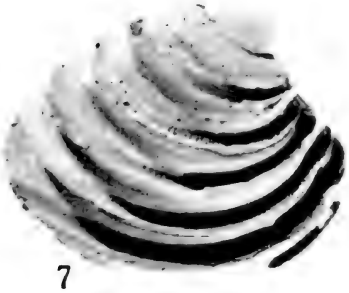
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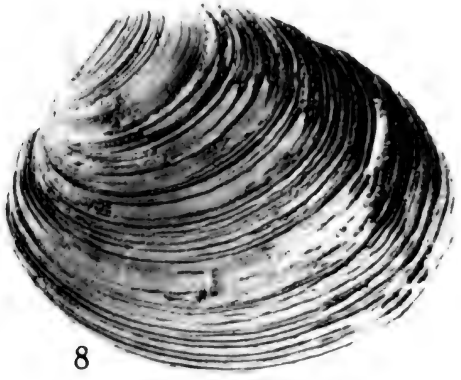
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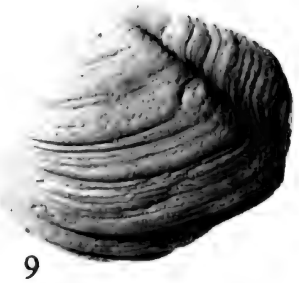
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PLATE 4

Mollusks of the *Costaglycymeris mixoni/Chesapecten jeffersonius* Interval-zone (M-7)

Figure

1. *Kuphus fistula* (H. C. Lea) (p. 115)
   Incomplete specimen (USNM 405299); 2.7 km below Bowlers Wharf, Essex Co., Va. (loc. 2, USGS loc. 26026); length 65.2 mm.
2. *Panopea goldfussii* Wagner (p. 113)
   Right valve (USNM 405294); 2.7 km below Bowlers Wharf, Essex Co., Va. (loc. 2, USGS loc. 26026); length 104.3 mm, height 57.7 mm.
3. *Turritella plebeia plebeia* Say (p. 115)
   Apertural view, neotype (USNM 405300); 2.7 km below Bowlers Wharf, Essex Co., Va. (loc. 2, USGS loc. 26026); height 40.2 mm.
4. *Anguinella virginica* (Conrad) (p. 120)
   View of several specimens (USNM 405311) adhering to each other in typical growth habit; below Whiting Creek, Middlesex County, Va.; width 15. 0 mm, height 13. 9 mm.
5. *Oliva idonea* Conrad (p. 135)
   Apertural view (USNM 405341); Union Mill, Richmond Co., Va.; height 47.7 mm.
6. *Conus spenceri* Ward, new species (p. 136)
   Apertural view, holotype (USNM 405344); Urbanna Creek, above Urbanna, Essex Co., Va.; height 35.9 mm.
7. *Busycotypus coronatum* (Conrad) (p. 131)
   Apertural view (USNM 405330); 2.7 km below Bowlers Wharf, Essex Co., Va. (loc. 2, USGS loc. 26026); height 134. 2mm.
8. *Ecphora kochi* Ward and Gilinsky (p. 121)
   Apertural view, holotype (USNM 405315); below Cobham Wharf, Surry Co., Va. (loc. 3, USGS loc. 26052); height 89.6 mm.
9. *Bulliopsis quadrata* (Conrad) (p. 133)
   Apertural view (USNM 405336); 2.7 km below Bowlers Wharf, Essex Co., Va. (loc. 2, USGS loc. 26026); height 27.7 mm.


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PLATE 5

Mollusks of the *Glossus fraterna/Costaglycymeris mixoni* Interval-zone (M-8)

Figure

1. *Dallarca virginiae* (Dall) (p. 57)
   Right valve, neotype (USNM 258351); just above Sunken Meadow Creek, Surry Co., Va. (USGS loc. 26041); length 82.2 mm, height 57.3 mm.
2. *Costaglycymeris virginiae* (Dall) (p. 62)
   Left valve, neotype (USNM 258350); Cobham Wharf, Surry Co., Va. (loc. 3, USGS loc. 26052); length 60.5 mm, height 65.1 mm.
3. *Dallarca carolinensis clisea* (Dall) (p. 56)
   Left valve (USNM 258353); just below the mouth of Upper Chippokes Creek on the James River, Surry Co., Va. (USGS loc. 26042); length 42.7 mm, height 44.1 mm.
4. *Isognomon (Hippochaeta)* sp. (p. 63)
   Right valve, nearly complete specimen (USNM 258347); Cobham Wharf, Va. (loc. 3, USGS loc. 26052); length 150.3 mm.
5. *Lucinoma contracta* (Say) (p. 80)
   Right valve (USNM 380704); just above the mouth of Sunken Meadow Creek on the right bank of the James River, Surry Co., Va. (USGS loc. 26041); length 21.6 mm, height 19.1 mm.

6, 7. *Dallarca carolinensis rotunda* Ward, new subspecies (p. 57)
   6. Exterior, left valve (USNM 380702); just above the mouth of Sunken Meadow Creek on the right bank of the James River, Surry Co., Va. (USGS loc. 26041), length 55. 6mm, height 54.5 mm.
   7. Interior, same specimen.

8. *Ostrea compressirostra brucei* new species (p. 77)
   Left valve (USNM 258356); just above Sunken Meadow Creek on the James River, Surry Co., Va. (USGS loc. 26041); length 97.7 mm, height 111.9mm.
9. *Chesapecten (Chesapecten) middlesexensis ceccae* Ward, new subspecies
   Holotype (USNM 258358), right valve; just above Sunken Meadow Creek, Surry Co., Va. (USGS loc. 26041); length 98.8 mm, height 91.4 mm.

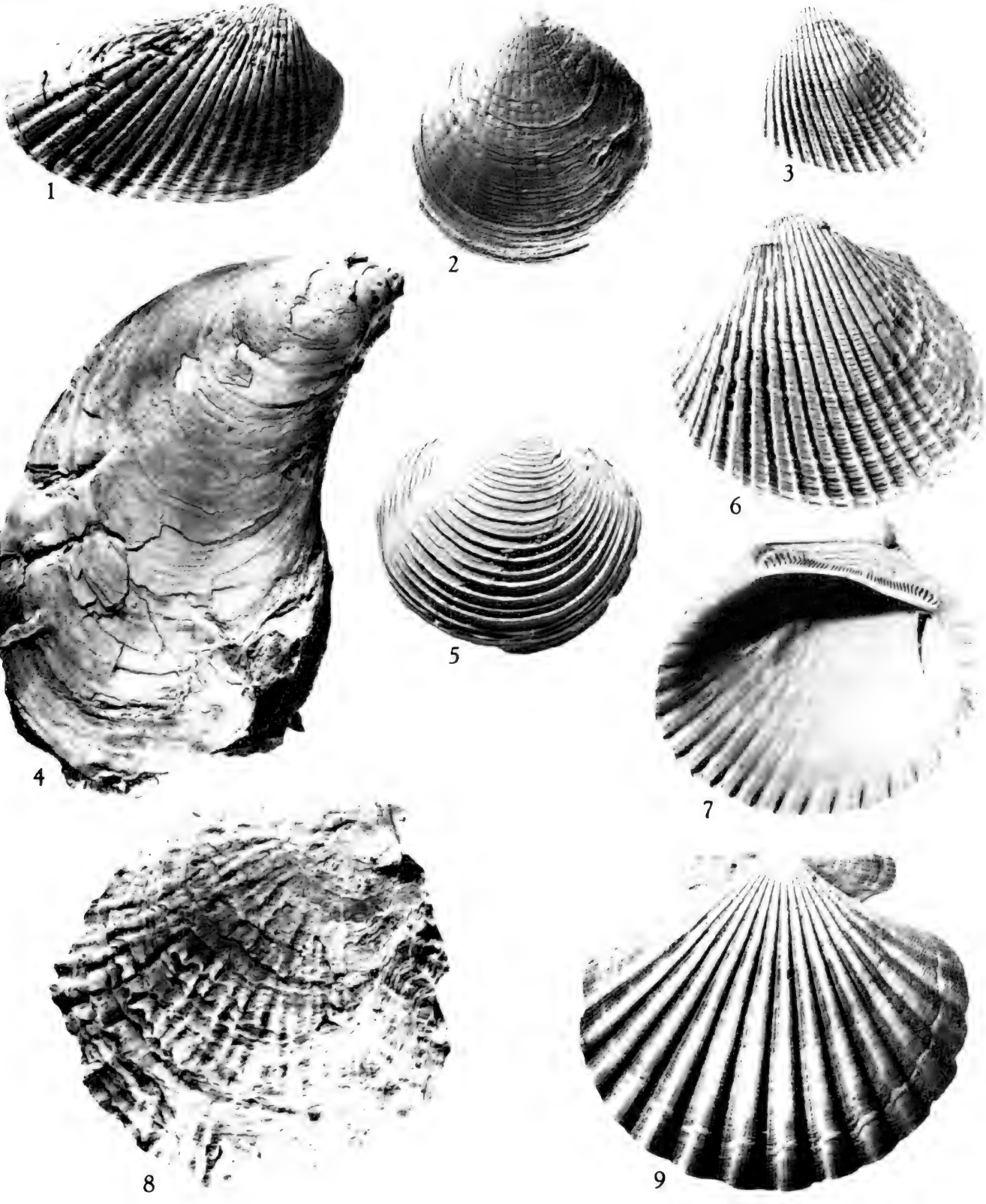
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PLATE 6

Mollusks of the *Glossus fraterna/Costaglycymeris mixoni* Interval-zone (M-8)

Figure

1. *Glossus fraterna* (Say) (p. 97)
   Left valve (USNM 258354); just below the mouth of Upper Chippokes Creek on the James River, Surry Co., Va. (USGS loc. 26345); length 82.3 mm, height 80.2 mm.
2. *Marvacrassatella surryensis* (Mansfield) (p. 87)
   Left valve (USNM 380705); just above the mouth of Sunken Meadow Creek on the right bank of the James River, Surry Co., Va. (USGS loc. 26041); length 93.8 mm, height 70.7 mm.
3. *Panopea goldfussii* Wagner (p. 113)
   Right valve (USNM 380703); just above the mouth of Sunken Meadow Creek on the right bank of the James River, Surry Co., Va. (USGS loc. 26041); length 93.8 mm, height 70.7 mm.
4. *Mercenaria druidi* Ward, new name (p. 107)
   Left valve (USNM 258349); just above Sunken Meadow Creek, Surry Co., Va. (USGS loc. 26041); length 93.5 mm, height 75. 9mm.
5. *Euloxa latisulcata* (Conrad) (p. 96)
   Left valve (USNM 258355); just below the mouth of Upper Chippokes Creek on the James River, Surry Co., Va. (USGS 26042); approx. length 15 mm, approx. height 13.1 mm.
6. *Lirophora dalli* (Olsson) (p. 105)
   Right valve (USNM 258352); Cobham Wharf, Surry Co., Va. (loc. 3, USGS loc. 26052); length 19.3 mm, height 17.2 mm.
7. *Ecphora gardnerae whiteoakensis* Ward, and Gilinksy (p. 122)
   Apertural view, incomplete specimen, holotype (USNM 280706); White Oak Landing, on the Mattaponi River, King William Co., Va. (loc. 8, USGS loc. 26046); height 70.2 mm.
8. *Ecphora gardnerae gardnerae* Wilson (p. 123)
   Apertural view (USNM 258348); just above Sunken Meadow Creek, Surry Co., Va. (USGS loc. 26041); height 74.4 mm.
9. *Turritella plebeia carinata* Gardner (p. 116)
   Apertural view, incomplete specimen (USNM 258357); just below the mouth of Upper Chippokes Creek on the James River, Surry Co., Va. (USGS loc. 26042); height 24. 3 mm.

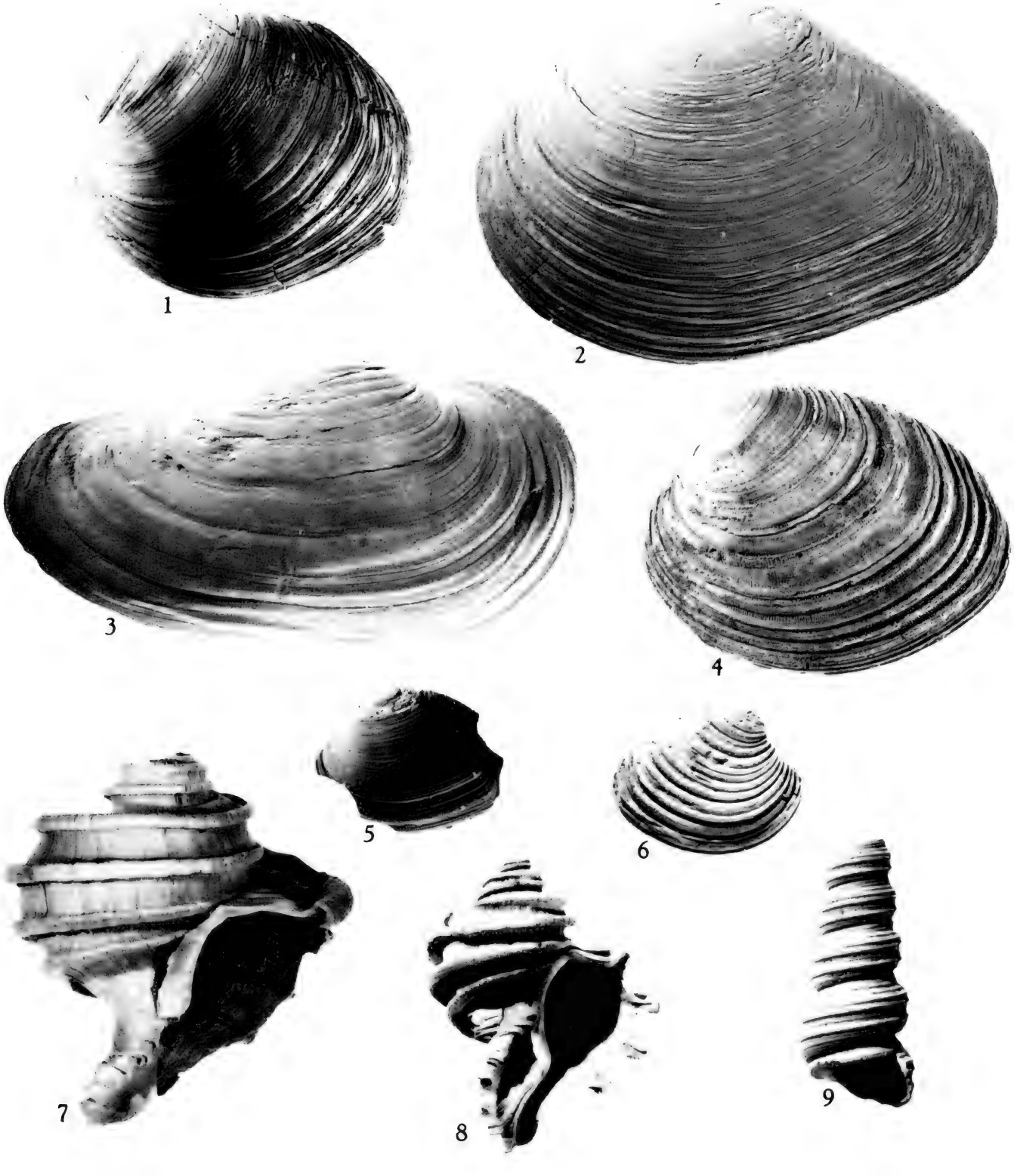
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Plate 7

Mollusks of the *Chesapecten santamaria/Glossus fraterna* Interval-zone (M-9)

Figure

1, 3. *Crassostrea* sp. (p. 76)
1. Interior, left valve (USNM 405215); Essex Mill, Essex Co., Va. (loc. 14, USGS loc. 26091); length 74.0 mm, height 101.1 mm.
3. Exterior, same specimen.

2. *Mercenaria tetrica* (Conrad) (p. 107)
Right valve (USNM 405287); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); length 124.2 mm, height 100.9 mm.

4. *Chesapecten (Chesapecten) santamaria* (Tucker) (p. 70)
Right valve (USNM 405198); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 25304); length 130.7 mm, height 119.6 mm.

5. *Astarte perplana* Conrad (p. 83)
Left valve, topotype specimen (USNM 405237); below Chancellor Point, St. Marys River, St. Marys Co., Md. (loc. 13, USGS loc. 26555); length 32.9 mm, height 26.4 mm.

6. *Glossus santamaria* Ward, new species (p. 98)
Holotype (USNM 405265), left valve; below Chancellor Point, St. Marys River, St. Marys Co., Md. (loc. 13, USGS loc. 26555); length 54.9 mm, height 58.9 mm.

7. *Lirophora alveata* (Conrad, 1830) (p. 105)
Right valve (USNM 405283); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); length 27.5 mm, height 25.5 mm.

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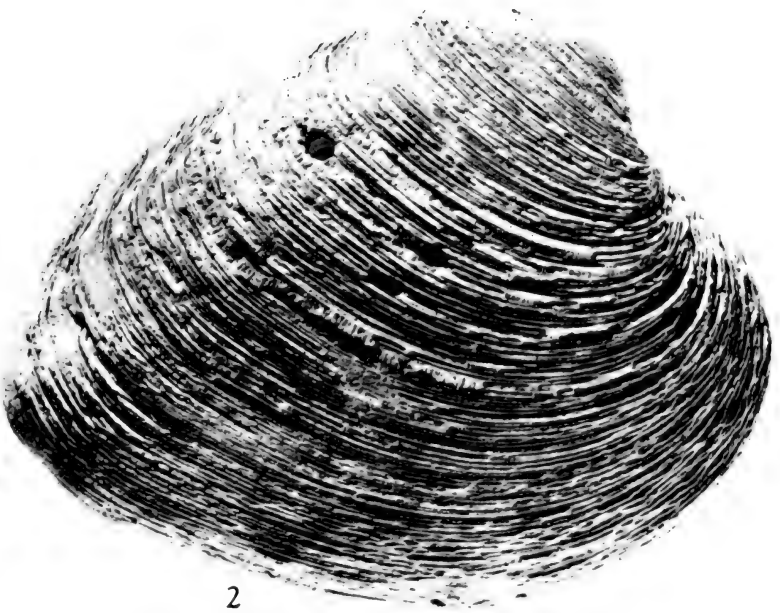

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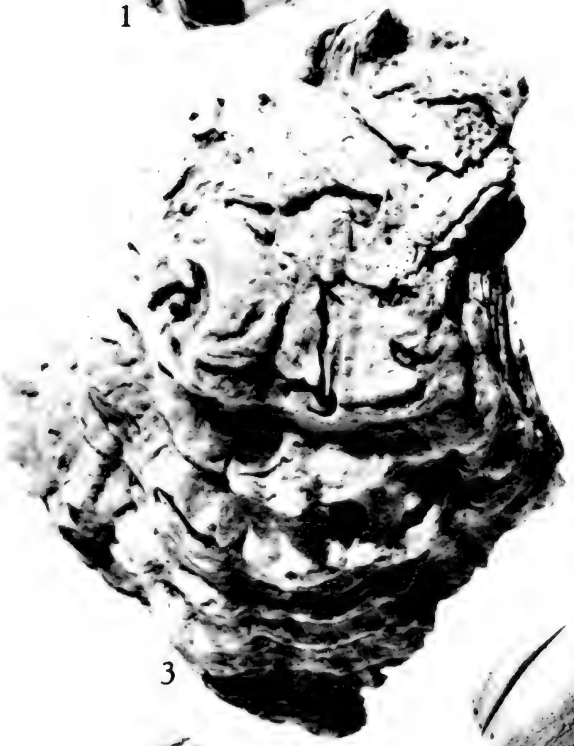

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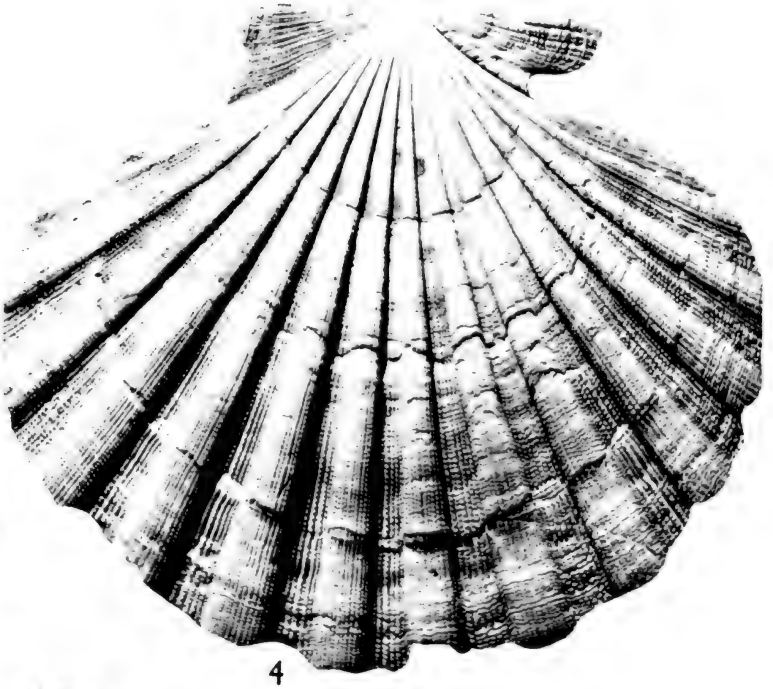

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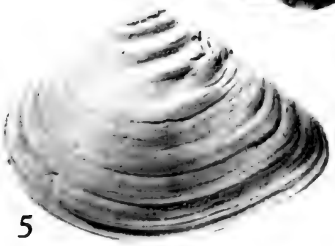

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PLATE 8

Mollusks of the *Chesapecten santamaria/Glossus fraterna* Interval-zone (M-9)

Figure

1, 2. *Dallarca idonea* (Conrad) (p. 58)
1. Exterior, left valve (USNM 405186); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); length 61. 9mm, height 55.0 mm.
2. Interior, same specimen

3. *Rasia andrewsi* Ward, new species (p. 54)
Holotype (USNM 405184), left valve; below Chancellor Point, St. Marys River, St. Marys Co., Md. (loc. 13, USGS loc. 26555); length 46.2 mm, height 30.6 mm.

4. *Turritella subvariabilis subvariabilis* d'Orbigny (p. 116)
Apertural view, neotype (USNM 405302); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); height 72.2 mm.

5. *Turritella plebeia plebeia* Say (p. 115)
Apertural view (USNM 405301); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); height 35.2 mm.

6. *Stewartia anodonta* (Say) (p. 79)
Left valve (USNM 405220); above Windmill Point, St. Marys River, St. Marys co., Md. (loc. 12, USGS loc. 26554); length 39.5 mm, height 37.8 mm.

7. *Dosinia acetabulum thori* Ward, new subspecies (p. 101)
Holotype (USNM 405274), right valve; above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); length 79.0 mm, height 74.0 mm.

8. *Leptomactra delumbis* (Conrad) (p. 94)
Left valve (USNM 405259); below Chancellor Point, St. Marys River, St. Marys Co., Md. (loc. 13, USGS loc. 26555); length 60.9 mm, height 38.0 mm.

9. *Chesacardium laqueatum laqueatum* (Conrad) (p. 90)
Right valve, neotype (USNM 405250); below Chancellor Point, St. Marys River, St. Marys Co., Md. (loc. 13, USGS loc. 26555); length 122.9 mm, height 120.8 mm.

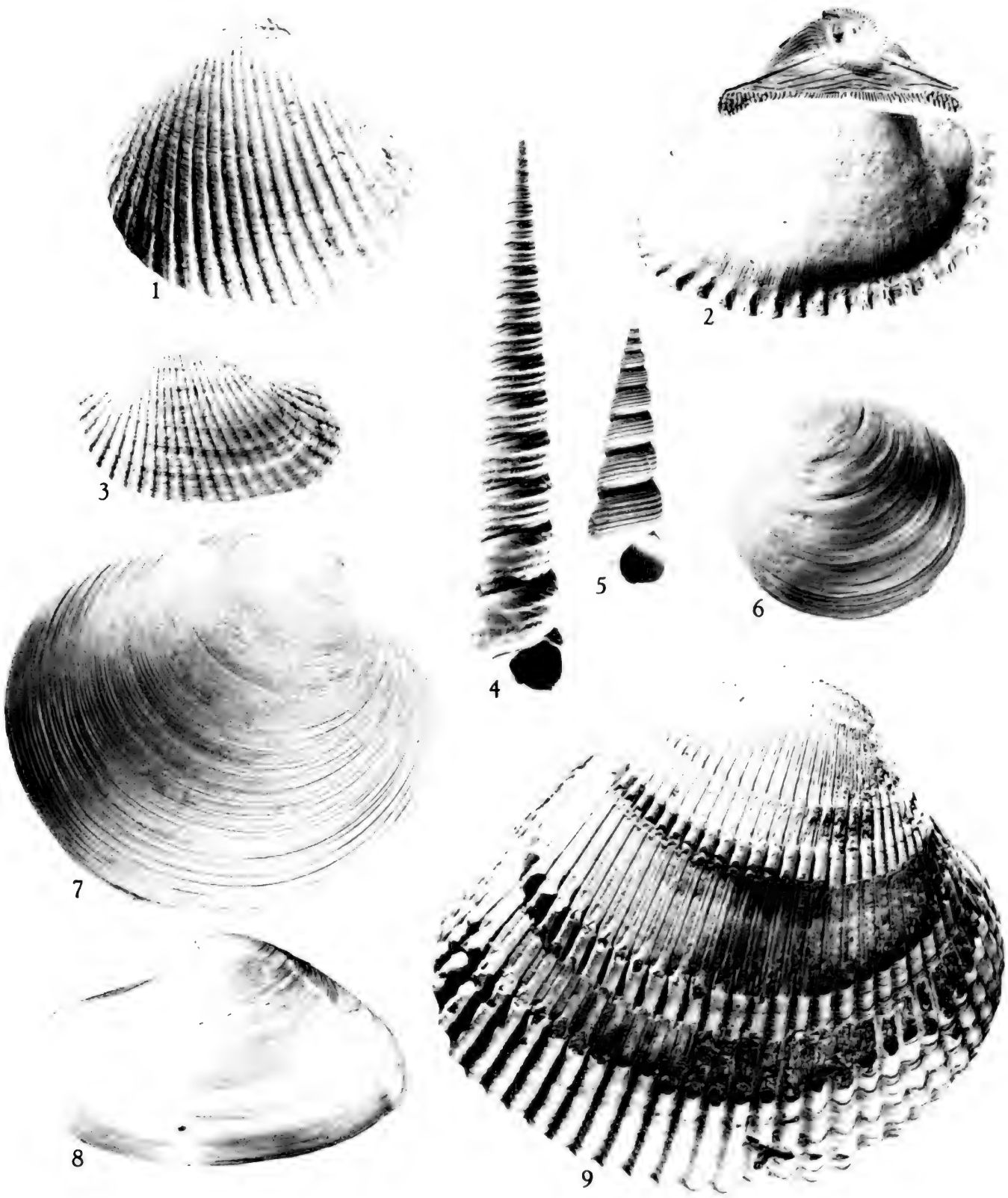
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Plate 9

Mollusks of the *Chesapecten santamaria/Glossus fraterna* Interval-zone (M-9)

Figure

1. *Conus deluvianus* Green (p. 136)
   Apertural view, neotype (USNM 405343); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); height 55.3 mm.
2. *Urosalpinx subrusticus* (d'Orbigny, 1852) (p. 130)
   Apertural view (USNM 405326); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); height 27.7 mm.
3. *Nassarius* (*Tritiaria*) *peralta* (Conrad) (p. 132)
   Apertural view, neotype (USNM 405335); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); height 14.9 mm.

4, 6. *Mactrodesma subponderosa* (d'Orbigny) (p. 93)
   4. Exterior, right valve (USNM 405256); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); length 103.8 mm, height 78.2 mm.
   6. Interior, left valve (USNM 405257); same locality; length 104.2 mm, height 80.9 mm.

5. *Buccinofusus parilis* (Conrad) (p. 134)
   Apertural view (USNM 405339); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); height 101.5 mm.

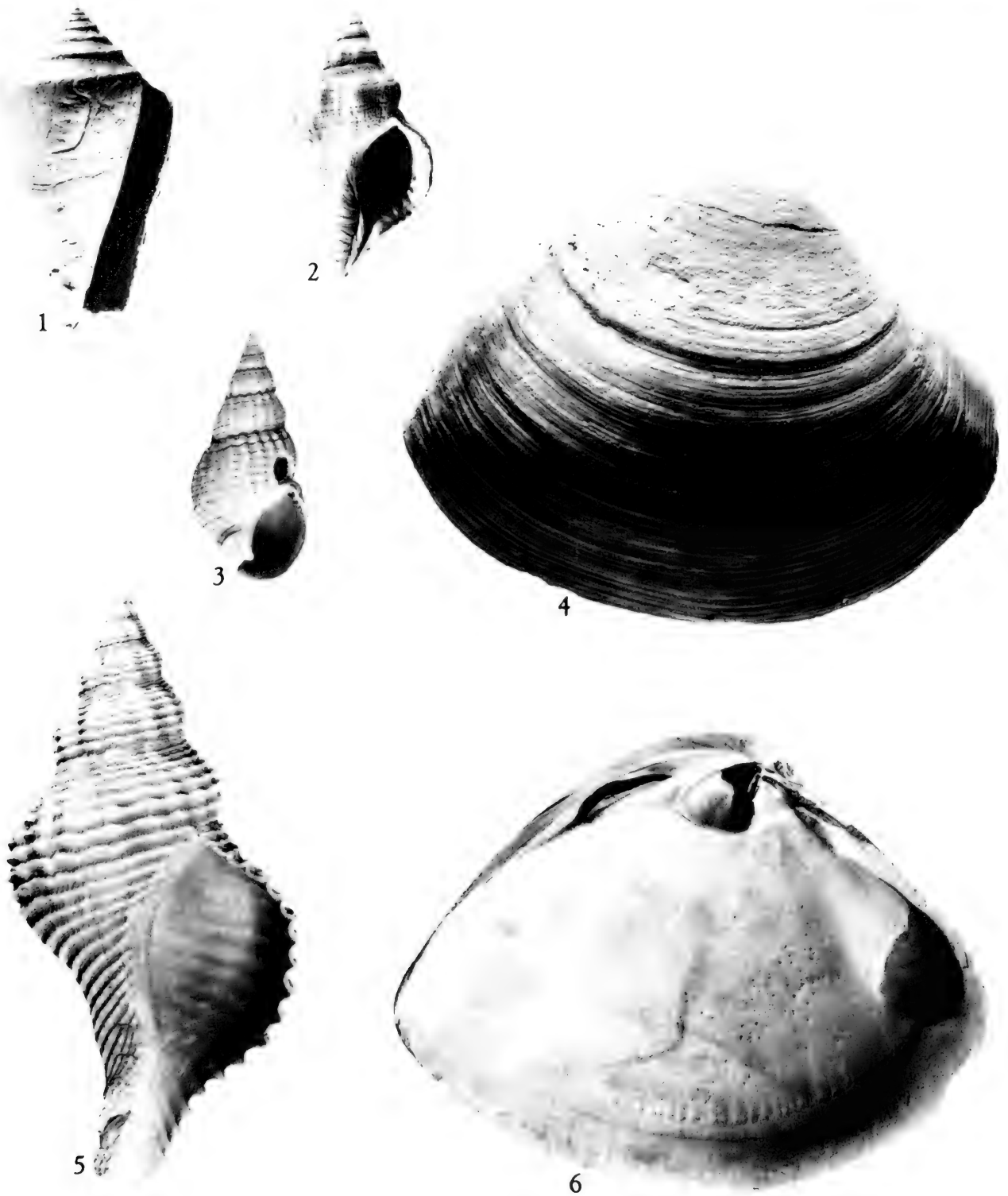
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Plate 10

Mollusks of the *Chesapecten santamaria/Glossus fraterna* Interval-zone (M-9)

Figure

1, 2. *Ecphora gardnerae gardnerae* Wilson (p. 123)

1. Apertural view (USNM 405317); Chancellor Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26555); height 85.7 mm.

2. Posterior view, same specimen.

3. *Busycotypus coronatum* (Conrad) (p. 131)

Apertural view (USNM 405331); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); height 139.0 mm.

4. *Busycotypus rugosum* (Conrad) (p. 132)

Apertural view, neotype (USNM 405333); above Windmill Point, St. Marys River, St. Marys Co., Md. (loc. 12, USGS loc. 26554); height 132.0 mm.

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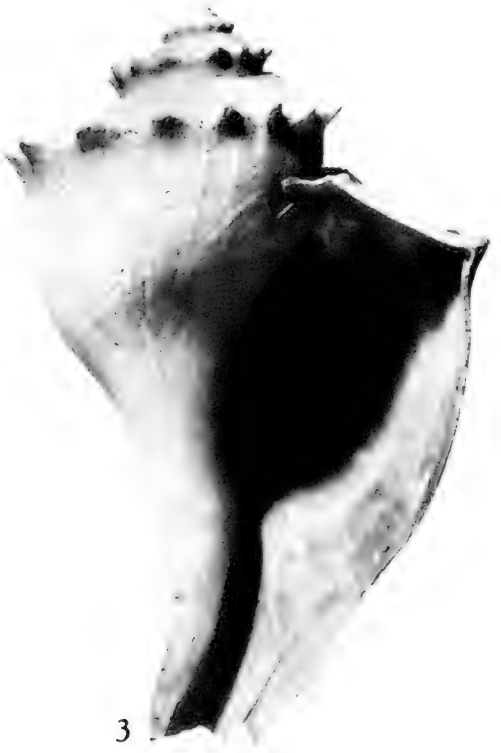

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Plate 11

Mollusks of the *Ecphora gardnerae germonae/Chesapecten santamaria* Interval-zone (M-10)

Figure

1, 5. *Dallarca idonea* ssp. (p. 58)

1. Left valve, somewhat abraded specimen (USNM 405187); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 45.4 mm, height 44.5 mm.

5. Left valve (USNM 405188); same locality; length 40.1 mm, height 36.0 mm.

2, 3, 6. *Chesapecten (Chesapecten) covepointensis* Ward, new species (p. 70)

2. Holotype (USNM 405199), right valve; below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 116.0 mm, height 111.6 mm.

3. Right valve (USNM 405201); same locality; length 115.5 mm, height 119.8 mm.

6. Left valve, paratype (USNM 405200); same locality; length 108.9 mm, height 108.0 mm.

4. "*Spisula*" subcuneata (Conrad) (p. 95)

Interior, left valve (USNM 405262); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 14.8 mm, height 10.2 mm.

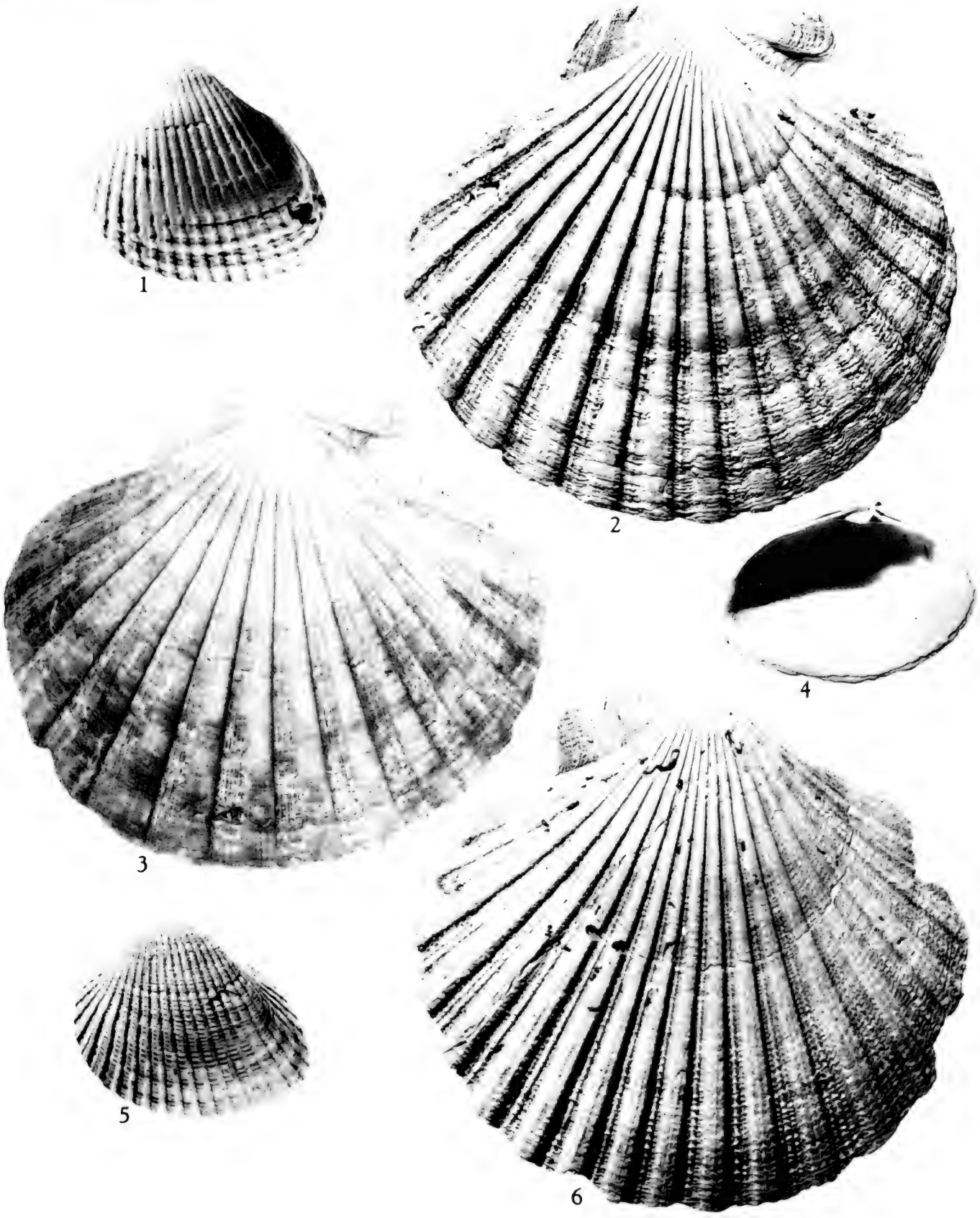
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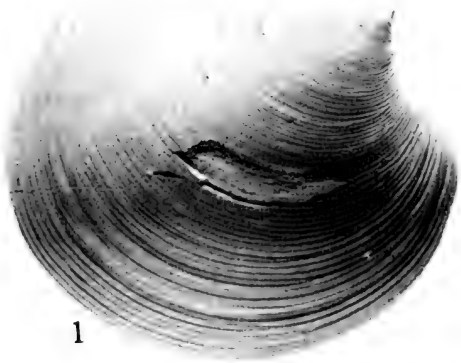
Plate 12

Mollusks of the *Ecphora gardnerae germonae/Chesapecten santamaria* Interval-zone (M-10)

Figure

1. *Dosinia acetabulum thori* Ward, new subspecies (p. 101)
   Paratype (USNM 405275), right valve; below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 59.6 mm, height 58.8 mm.
2. *Chesacardium laqueatum eshelmani* Ward, new subspecies (p. 91)
   Right valve, holotype (USNM 405252); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 94.1 mm, height 78.3 mm.
3. *Clementia inoceriformis* (Wagner) (p. 103)
   Right valve (USNM 405278); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 59.6 mm, height 58.8 mm.
4. *Panopea goldfussii* Wagner (p. 113)
   Left valve (USNM 405295); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 82.8 mm, height 80.2 mm.
5. *Mercenaria cuneata* ssp. (p. 108)
   Right valve (USNM 405289); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 85.8 mm, height 75.7 mm.
6. *Mactrodesma subponderosa* (d'Orbigny) (p. 93)
   Right valve (USNM 405258); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 91.0 mm, height 72.5 mm.
7. *Mercenaria tetrica* ssp. (p. 108)
   Left valve (USNM 405288); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); length 85.2 mm, height 80.5 mm.



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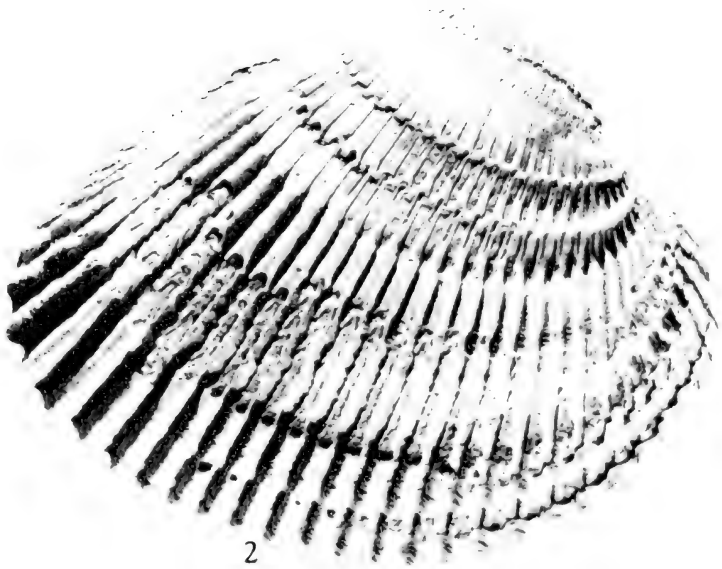

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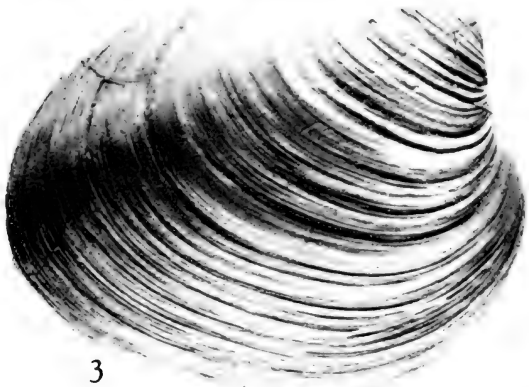

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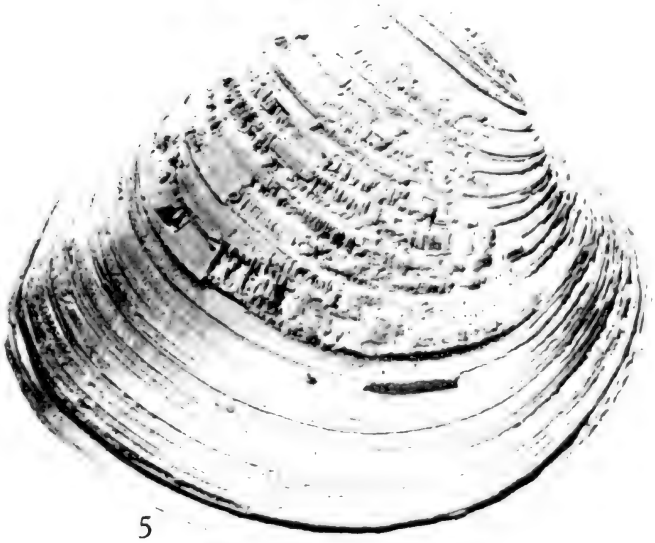

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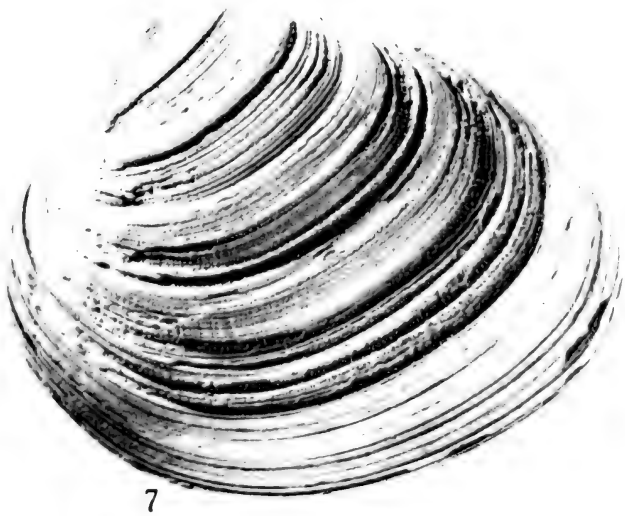

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Plate 13

Mollusks of the *Ecphora gardnerae germonae/Chesapecten santamaria* Interval-zone (M-10)

Figure

1, 2. *Ecphora gardnerae germonae* Ward and Gilinsky (p. 124)
   1. Apertural view (USNM 405318); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); height 77.9 mm.
   2. Posterior view, same specimen.

3. *Bulliopsis marylandica* (Conrad) (p. 133)
   Apertural view, neotype (USNM 405337); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); height 27.3 mm.

4, 5. *Turritella subvariabilis bohaskai* Ward, new subspecies. (p. 117)
   4. Apertural view, holotype (USNM 405303); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); height 39.1 mm.
   5. Apertural view, paratype (USNM 405304); same locality.

6. *Terebra simplex* Conrad (p. 137)
   Apertural view (USNM 405345); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); height 32.8 mm.

7. *Buccinofusus chesapeakensis* Petuch (p. 134)
   Apertural view (USNM 405340); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); height 118.2 mm.

8. *Busycotypus coronatum* (Conrad) (p. 131)
   Apertural view (USNM 405332); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); height 81.1 mm.

9. *Busycon fusiforme* (Conrad) (p. 131)
   Apertural view (USNM 405328); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); height 50.0 mm.

10. *Busycotypus rugosum* (Conrad) (p. 132)
   Apertural view (USNM 405334); below Little Cove Point, on the Chesapeake Bay, Calvert Co., Md. (loc. 15, USGS loc. 26556); height 84.3 mm.


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Plate 14

Mollusks of the *Marvacrassatella marylandica/Ecphora gardnerae germonae* Interval-zone (M-11)

Figure

1-6. *Chesapecten (Chesapecten) monicae* Ward, new species (p. 71)

From below Flag Pond, on the Chesapeake Bay, Calvert Co., Md. (loc. 17, USGS loc. 26558).

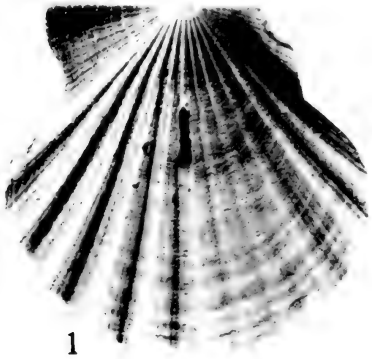
1. Exterior, holotype (USNM 405204), left valve, length 32.6 mm, height 32.8 mm.
2. Exterior, paratype (USNM 405205), left valve, length 33.5 mm, height 33.6 mm.
3. Exterior, paratype (USNM 405206), right valve, length 31.5 mm, height 31.5 mm.
4. Interior, paratype (USNM 405207), left valve, length 18.5 mm, height 18.9 mm.
5. Interior, left valve, same specimen as figure 2.
6. Interior, right valve, same specimen as figure 3.

7, 9. *Marvacrassatella marylandica* (Conrad) (p. 87)

7. Exterior, left valve (USNM 405248); below Flag Pond, on the Chesapeake Bay, Calvert Co., Md. (loc. 17, USGS loc. 26558); length 86.5 mm, height 57.7 mm.
9. Interior, same specimen.

8, 10. *Dallarca elevata* (Conrad) (p. 58)

8. Exterior, left valve (USNM 405189); below Flag Pond, on the Chesapeake Bay, Calvert Co., Md. (loc. 17, USGS loc. 26558); length 41.2 mm, height 36.3 mm.
10. Interior, same specimen.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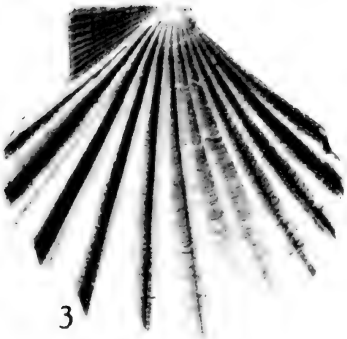
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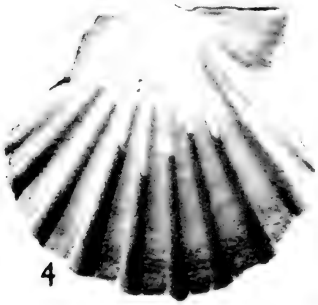
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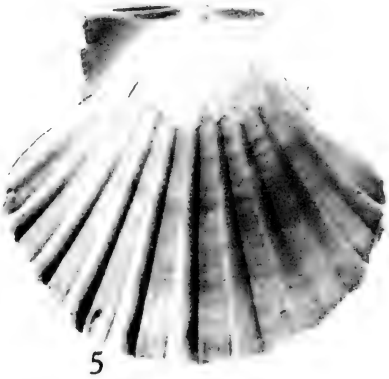
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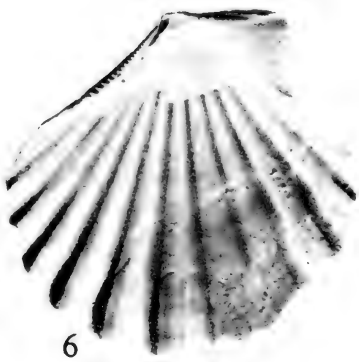
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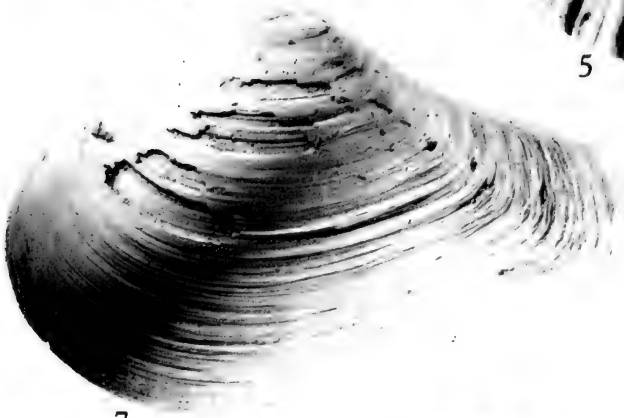
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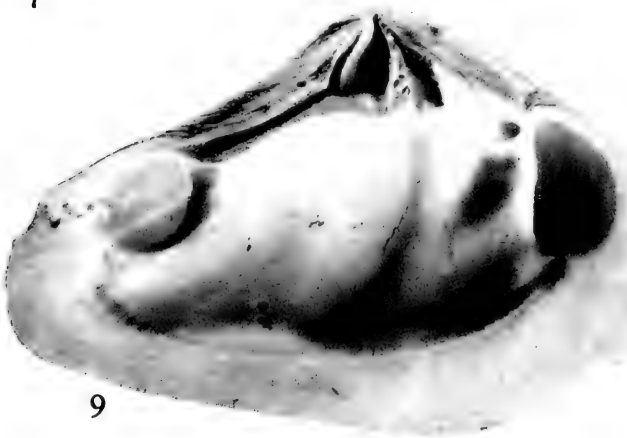
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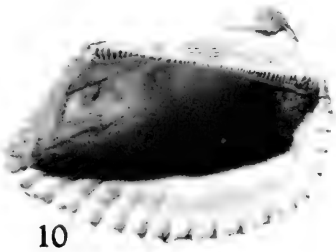
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Plate 15

Mollusks of the *Marvacrassatella marylandica/Ecphora gardnerae* Interval-zone (M-11)

Figure

1, 2. *Ecphora meganae williamsi* Ward and Gilinsky (p. 125)
   1. Posterior view, holotype (USNM 405319); from below Flag Pond, on the Chesapeake Bay, Calvert Co., Md. (loc. 17, USGS loc. 26558); height 55.4 mm.
   2. Apertural view, same specimen.

3. *Astarte obruta* Conrad (p. 84)
   Exterior, left valve, topotype (USNM 405238); below Dover Bridge, on the Choptank River, Talbot Co., Md.; length 23.4 mm, height 21.0 mm.

4. *Chesapecten (Chesapecten) nefrens* Ward and Blackwelder (p. 71)
   Right valve, holotype (USNM 193442); Camp Conoy, on the western shore of the Chesapeake Bay, Calvert County, Md. (USGS loc. 25299); length 177.4 mm, height 158.8 mm.

5. *Turritella terebriformis* Dall (p. 118)
   Apertural view, broken specimen (USNM 405305); below Flag Pond, on the Chesapeake Bay, Calvert Co., Md. (loc. 17, USGS loc. 26558); height 77.9.

6. *Chesacardium laqueatum vostreysi* Ward, new subspecies (p. 91)
   Holotype, left valve (USNM 405253); below Flag Pond, on the Chesapeake Bay, Calvert Co., Md. (loc. 17, USGS loc. 26558); length 83.3 mm, height 77.5 mm.

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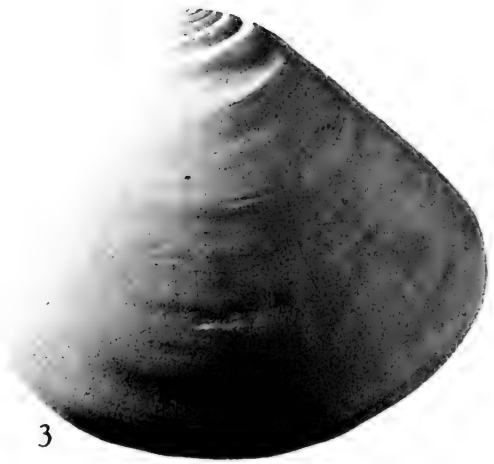

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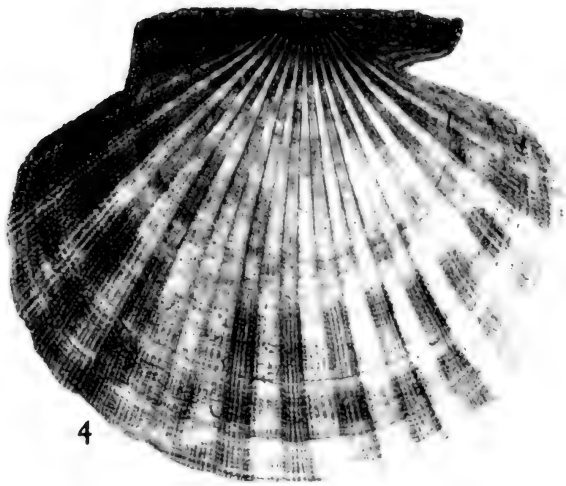

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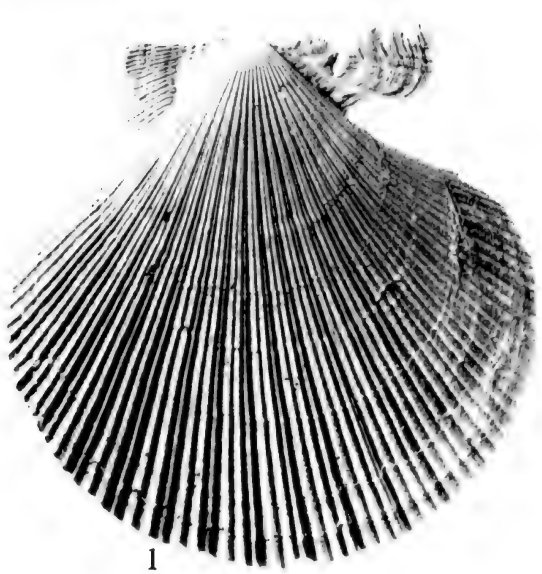
Plate 16

Mollusks of the *Marvacrassatella turgidula/Marvacrassatella marylandica* Interval-zone (M-12)

Figure

1. *Chesapecten* (*Christinapecten*) *marylandica* (Wagner) (p. 74)
   Neotype, right valve (USNM 405211); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 69.9 mm, height 71.1 mm.
2. *Chesapecten (Chesapecten) nefrens* Ward and Blackwelder (p. 71)
   Right valve (USNM 405202); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 77.5 mm, height 78.3 mm.
3. *Panopea goldfussii* Wagner (p. 113)
   Neotype, right valve (USNM 405296); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 101.4 mm, height 52.3 mm.
4. *Florimetis biplicata* (Conrad) (p. 96)
   Right valve (USNM 405263); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 53.4 mm, height 44.0 mm.
5. *Panopea americana* Conrad (p. 114)
   Right valve (USNM 405298); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 165.0 mm, height 98.8 mm.
6. *Dallarca elnia* (Glenn) (p. 59)
   Left valve (USNM 405190); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 42.8 mm, height 37.5 mm.



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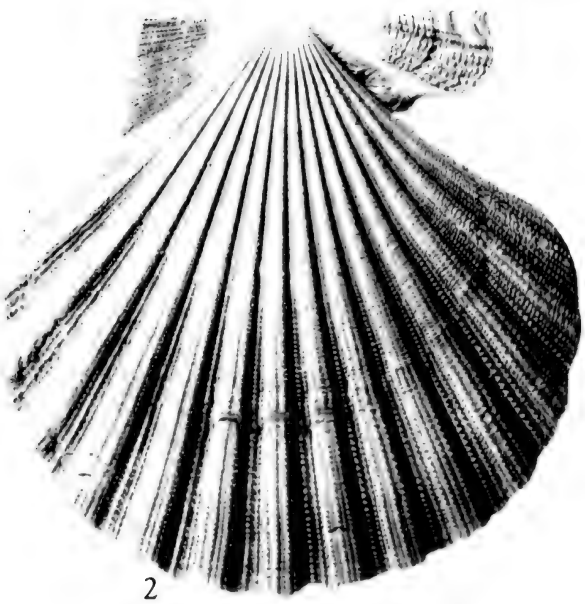

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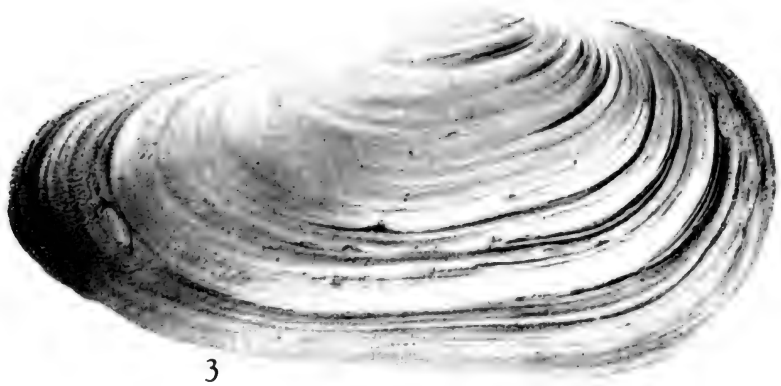

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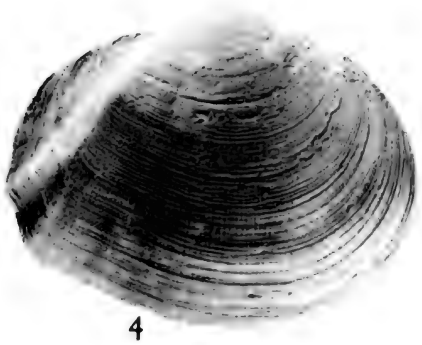

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Plate 17

Mollusks of the *Marvacrassatella turgidula/Marvacrassatella marylandica* Interval-zone (M-12)

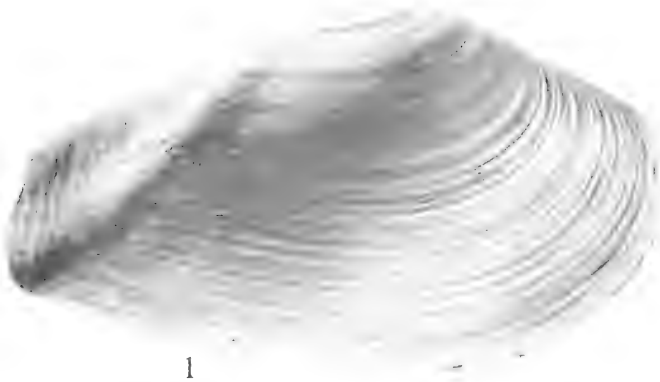
Figure

1, 2. *Marvacrassatella turgidula* Conrad (p. 87)
   1. Exterior, right valve (USNM 405249); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 89.5 mm, height 53.5 mm.
   2. Interior, same specimen.

3, 5. *Leptomactra marylandica* (Dall) (p. 94)
   3. Exterior, right valve, topotype (USNM 405260); from Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 90.0 mm, height 60.2 mm.
   5. Interior, same specimen.

4. *Chesacardium laqueatum blackwelderi* Ward, new subspecies (p. 92)
   Holotype, left valve (USNM 405254); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 101.5 mm, height 91.9 mm.

6. *Pleiorytis calvertensis* (Dall) (p. 111)
   Right valve (USNM 405292); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 45.8 mm, height 28.5 mm.



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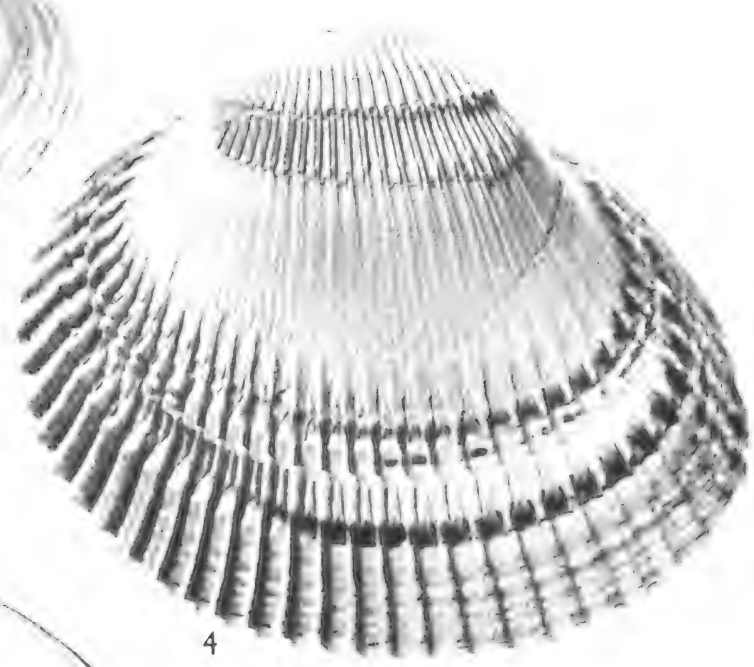

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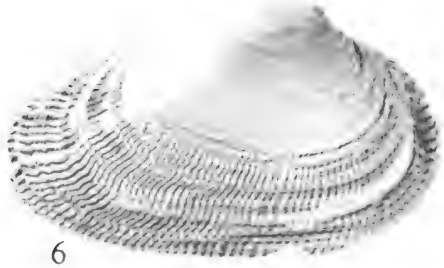

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Plate 18

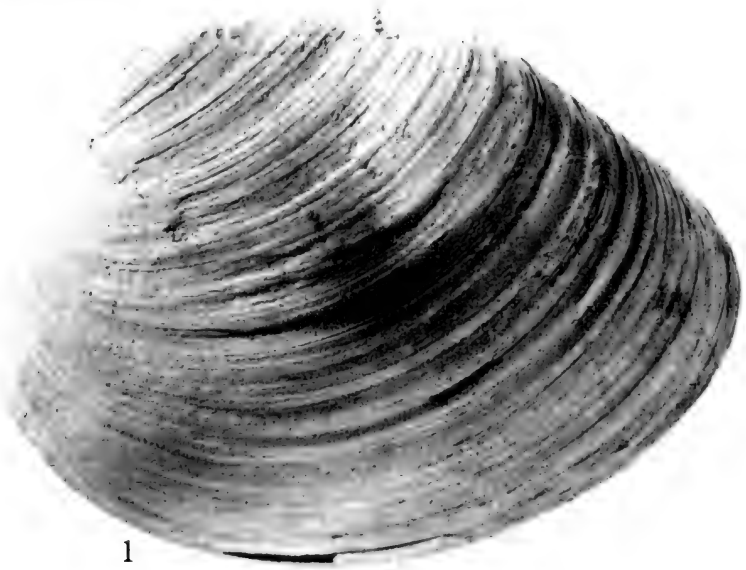
Mollusks of the *Marvacrassatella turgidula/Marvacrassatella marylandica* Interval-zone (M-12)

Figure

1. *Macrocallista marylandica* (Conrad) (p. 101)
   Neotype, left valve (USNM 405272); below Flag Pond, on the Chesapeake Bay, Calvert Co., Md. (USGS loc. 24001) (= loc. 17, USGS loc. 26558); length 109.1 mm, height 83.7 mm.
2. *Dosinia acetabulum blackwelderi* Ward, new subspecies (p. 102)
   Holotype, left valve (USNM 405276); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc.26557); length 73.9 mm, height 75.8 mm.
3. *Mercenaria cuneata* Conrad (p. 108)
   Neotype, right valve (USNM 405290); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 103.9 mm, height 95.2 mm.
4. *Glossus marylandica* (Schoonover) (p. 98)
   Left valve (USNM 405268); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 58.4 mm, height 50.1 mm.

5, 8. *Chesapecten*(?) *skiptonensis* (Mansfield) (p. 72)
   5. Right valve (USNM 405210); below Chesapeake Beach, on the Chesapeake Bay, Calvert Co., Md.; length 36.7 mm, height 38.2 mm.
   8. Interior, same specimen.

6, 7. *Lirophora parkeria* (Glenn) (p. 106)
   6. Right valve (USNM 405284); above Scientists Cliffs, on the Chesapeake Bay, Calvert Co., Md. (loc. 18, USGS loc. 26559); length 31.8 mm, height 25.1 mm.
   7. Left valve (USNM 405285); same locality; length 32.0 mm, height 25.8 mm.



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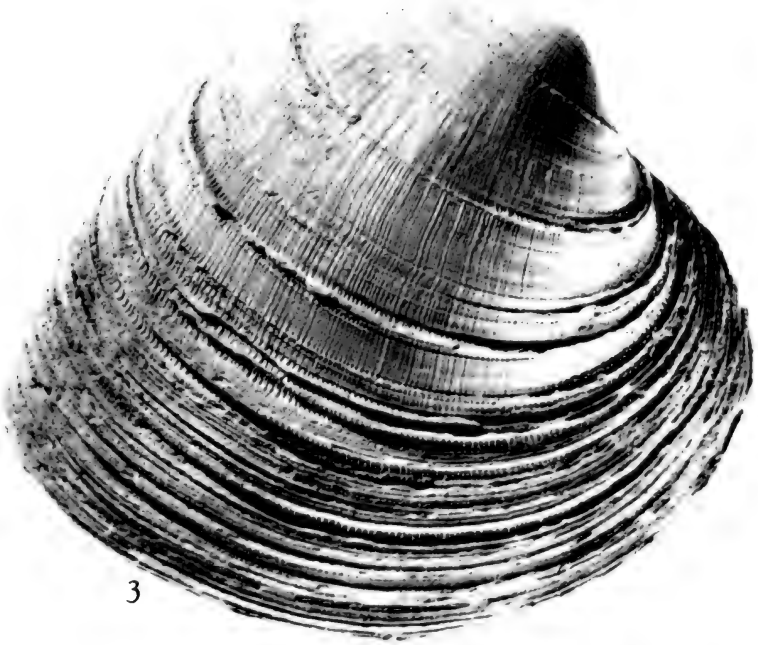

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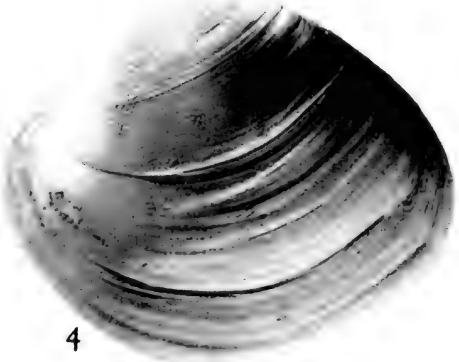

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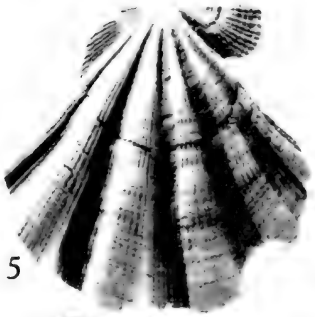

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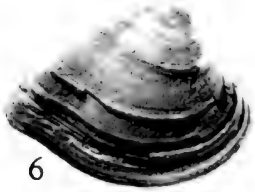

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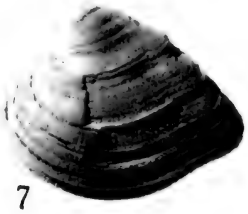

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Plate 19

Mollusks of the *Marvacrassatella turgidula/Marvacrassatella marylandica* Interval-zone (M-12)

Figure

1. *Stewartia anodonta* (Say) (p. 79)
   Right valve (USNM 405221); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 46.2 mm, height 49.0 mm.
2. *Lucinoma contracta* (Say) (p. 80)
   Right valve (USNM 405225); Calvert Beach, on the Chesapeake Bay, Calvert Co., Md.; length 37.8 mm, height 34.0 mm.
3. *Timothynus subvexa* (Conrad) (p. 80)
   Interor, right valve (USNM 405227); Calvert Beach, on the Chesapeake Bay, Calvert Co., Md.; length 35.6 mm, height 32.1 mm.
4. *Astarte thisphila* Glenn (p. 84)
   Left valve, topotype (USNM 405239); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); length 27.0 mm, height 25.3 mm.
5. *Isognomon* (*Hippochaeta*) sp. (p. 63)
   Left valve, nearly complete specimen (USNM 405192); Long Beach, on the Chesapeake Bay, Calvert Co., Md.; length 105 mm.

6, 7. *Ecphora meganae meganae* Ward and Gilinsky (p. 126)
   6. Apertural view, holotype (USNM 405320); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); height 64.6 mm.
   7. Posterior view, same specimen.

8. *Turritella subvariabilis dianae* Ward, new subspecies (p. 117)
   Apertural view, holotype (USNM 405306); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); height 21.4 mm.
9. *Scaphella virginiana* Dall (p. 135)
   Apertural view, neotype (USNM 405342); Drumcliff (Jones Wharf), on the Patuxent River, St. Marys Co., Md. (loc. 16, USGS loc. 26557); height 74.0 mm.

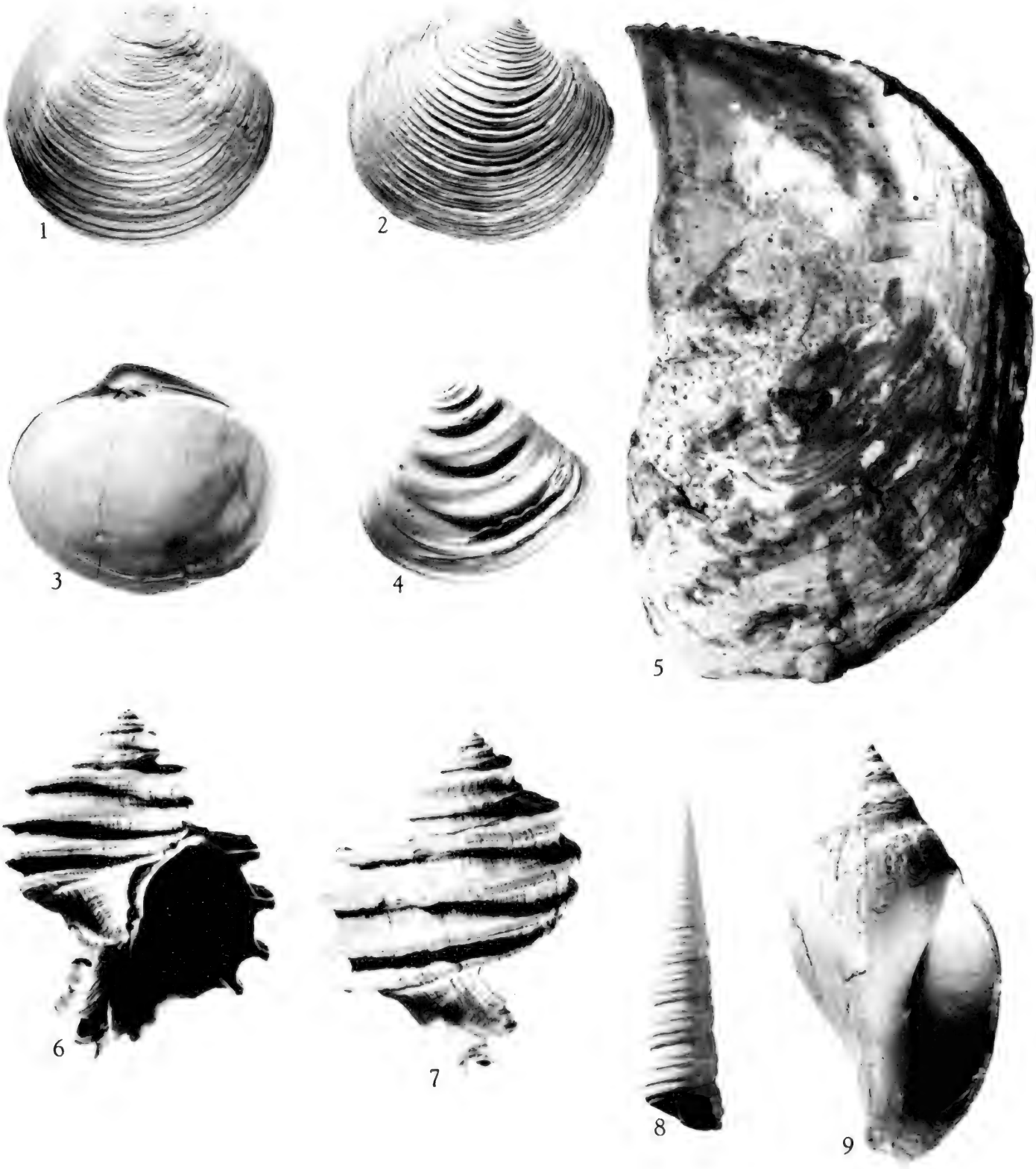
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Plate 20

Mollusks of the *Pecten humphreysii/Marvacrassatella turgidula* Interval-zone (M-13)

Figure

1, 3. *Chesapecten (Chesapecten) coccymelus* (Dall) (p. 72)
1. Right valve (USNM 405208); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 48.9 mm, height 50.9 mm.
3. Left valve (USNM 405209); same locality; length 49.0 mm, height 50.3 mm.

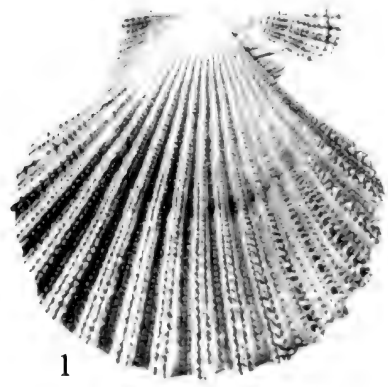
2. *Glycymeris parilis* (Conrad) (p. 60)
Lectotype (ANSP 30631), left valve; "Cliffs of Calvert, Md." (Conrad, 1843).

4. *Pecten humphreysii* Conrad (p. 67)
Right valve, neotype (USNM 380693); Plum Point, on the Chesapeake Bay, Calvert Co., Md.; length 52.2 mm, height 47.6 mm.

5. *Dallarca subrostrata* (Conrad) (p. 59)
Lectotype (ANSP 14027), right valve; from Conrad's type material from the "Calvert Cliffs, Maryland"; length 65.5 mm, height 44.0 mm.

6. *Eburneopecten cerinus* Conrad (p. 66)
Right valve (USNM 405195); Plum Point, on the Chesapeake Bay, Calvert Co., Md.; length 24.5 mm, height 24.9 mm.

7, 8. *Hyotissa haitensis* (Sowerby) (p. 76)
7. Left valve (USNM 405214); Plum Point, on the Chesapeake Bay, Calvert Co., Md.; length 66.2 mm, height 86.2 mm.
8. Interior, same specimen.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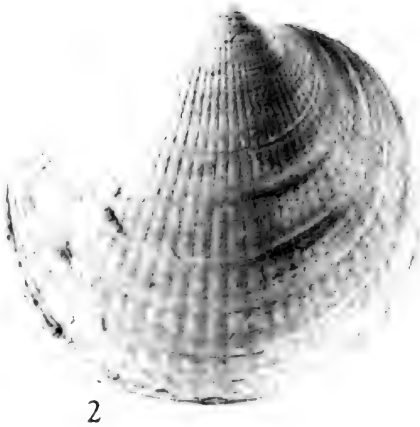
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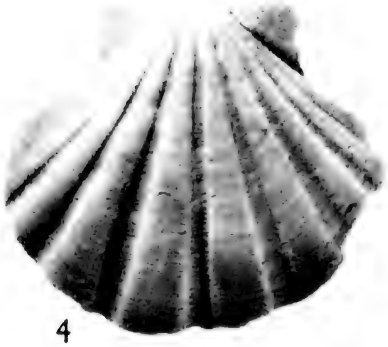
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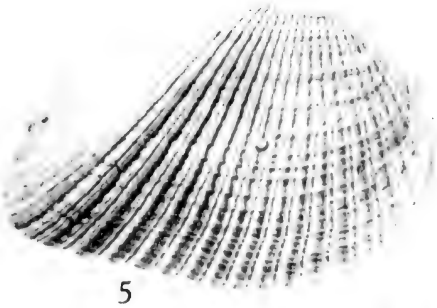
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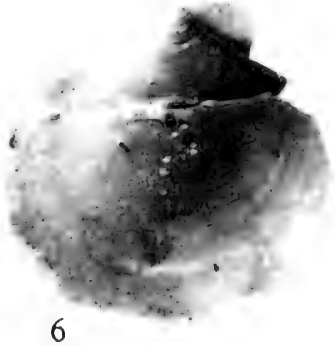
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Plate 21

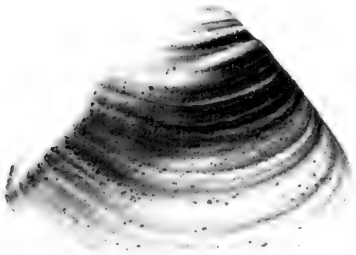
Mollusks of the *Pecten humphreysii/Marvacrassatella turgidula* Interval-zone (M-13)

Figure

1. *Bicorbula idonea* (Conrad) (p. 112)
   Right valve (USNM 380694); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 28.0 mm, height 24.9 mm.
2. *Varicorbula elevata* (Conrad) (p. 113)
   Right valve (USNM 405293); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 12.3 mm.
3. *Pycnodonte percrassa* (Conrad) (p. 75)
   Interior, left valve (USNM 405213); Holland Cliff, on the Patuxent River, Calvert Co., Md.; length 92.2 mm, height 89.9 mm.
4. *Panopea whitfieldi* Dall (p. 114)
   Right valve (USNM 405297); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 95.3 mm, height 50.2 mm.
5. *Chesacardium craticuloides* (Conrad) (p. 92)
   Neotype, left valve (ANSP 30625); "Calvert Cliffs, Md." (Conrad, 1845); length 38.0 mm, height 36.3 mm.
6. *Melosia staminea* (Conrad) (p. 100)
   Right valve (USNM 380697); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 30.0 mm, height 28.0 mm.

7, 8. *Stewartia foremani* (Conrad) (p. 79)
   7. Exterior, right valve (USNM 405224); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 37.1 mm, height 35.5 mm.
   8. Interior, same specimen.

9. *Stewartia anodonta* (Say) (p. 79)
   Right valve (USNM 405222); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 39.4 mm, height 37.0 mm.
10. *Isognomon* (*Hippochaeta*) sp. (p. 63)
    Right valve, nearly complete specimen (USNM 405193); Plum Point, on the Chesapeake Bay, Calvert Co., Md.; length 95 mm.



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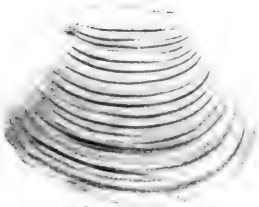

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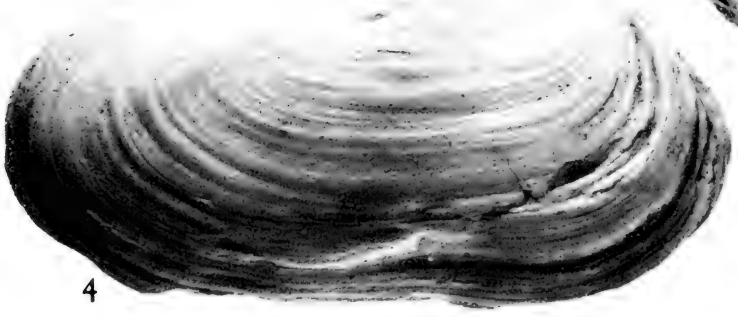

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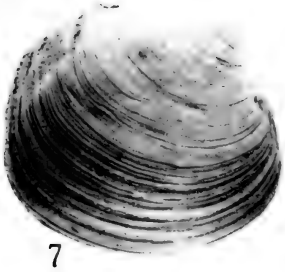

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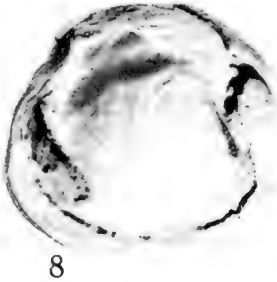

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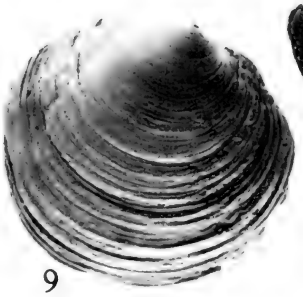

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Plate 22

Mollusks of the *Pecten humphreysii/Marvacrassatella turgidula* Interval-zone (M-13)

Figure

1, 2. *Glossus mazlea* (Glenn) (p. 99)
   1. Exterior, right valve (USNM 405270); Plum Point, on the Chesapeake Bay, Calvert Co., Md.; length 48.0 mm, height 43.0 mm.
   2. Interior, same specimen.

3, 4. *Glossus markoei* (Conrad) (p. 99)
   3. Exterior, right valve (USNM 405269); Plum Point, on the Chesapeake Bay, Calvert Co., Md.; length 46.6 mm, height 47.0 mm.
   4. Interior, same specimen.

5. *Astarte cuneiformis* Conrad (p. 85)
   Left valve (USNM 405240); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 31.2 mm, height 22.5 mm.

6. *Mercenaria blakei* Ward, new species (p. 109)
   Holotype, right valve (USNM 405291); Camp Roosevelt on the Chesapeake Bay, Calvert Co., Md.; length 81.0 mm, height 60.8 mm.

7. *Macrocallista marylandica* (Conrad) (p. 101)
   Left valve (USNM 405273); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 62.4 mm, height 43.0 mm.

8. *Marvacrassatella melina* (Conrad) (p. 88)
   Left valve (USNM 380700); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 80.9 mm, height 51.8 mm.

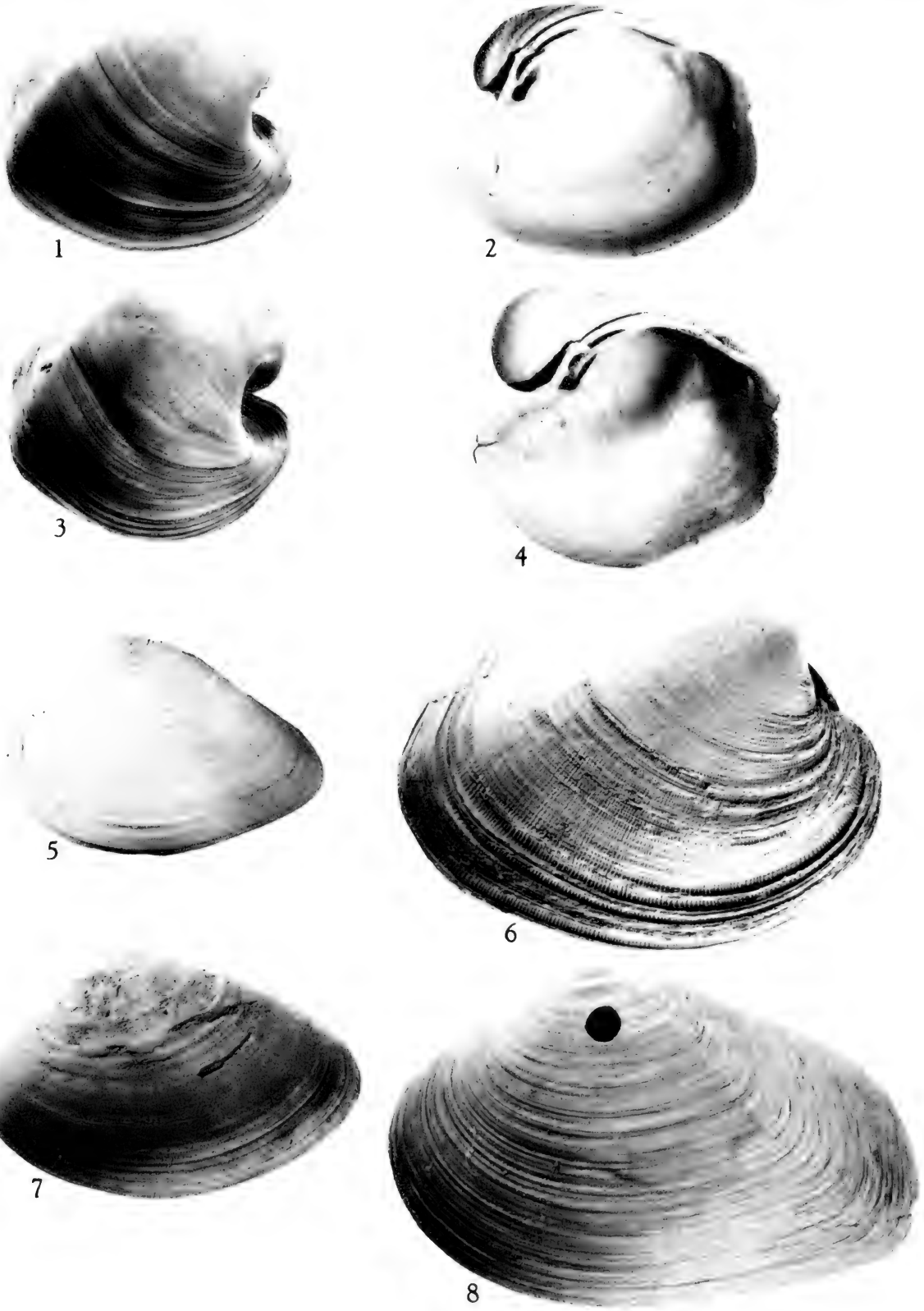
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Plate 23

Mollusks of the *Pecten humphreysii/Marvacrassatella turgidula* Interval-zone (M-13)

Figure

1, 2, 7, 8. *Ecphora tricostata tricostata* Martin (p. 128)

1. Apertural view (USNM 405321); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; height 55.8 mm.
2. Posterior, same specimen.
7. Apertural view (USNM 405322); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; height 70.3 mm.
8. Posterior, same specimen.

3, 4. *Ecphora tricostata pamlico* Wilson (p. 128)

3. Apertural view (USNM 380701); Plum Point, on the Chesapeake Bay, Calvert Co., Md.; height 73.6 mm.
4. Posterior, same specimen.

5. *Lirophora latilirata* (Conrad) (p. 106)

Right valve (USNM 405286); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; length 20.4 mm, height 14.9 mm.

6, 9. *Turritella exaltata* Conrad (p. 118)

6. Apertural view (USNM 405307); Plum Point, on the Chesapeake Bay, Calvert Co., Md.; height 95.0 mm.
9. Apertural view (USNM 405308); same locality; height 93.0 mm.

10. *Turritella indenta* Conrad (p. 119)

Apertural view, neotype (USNM 405309); Camp Roosevelt, on the Chesapeake Bay, Calvert Co., Md.; height 57.2 mm.

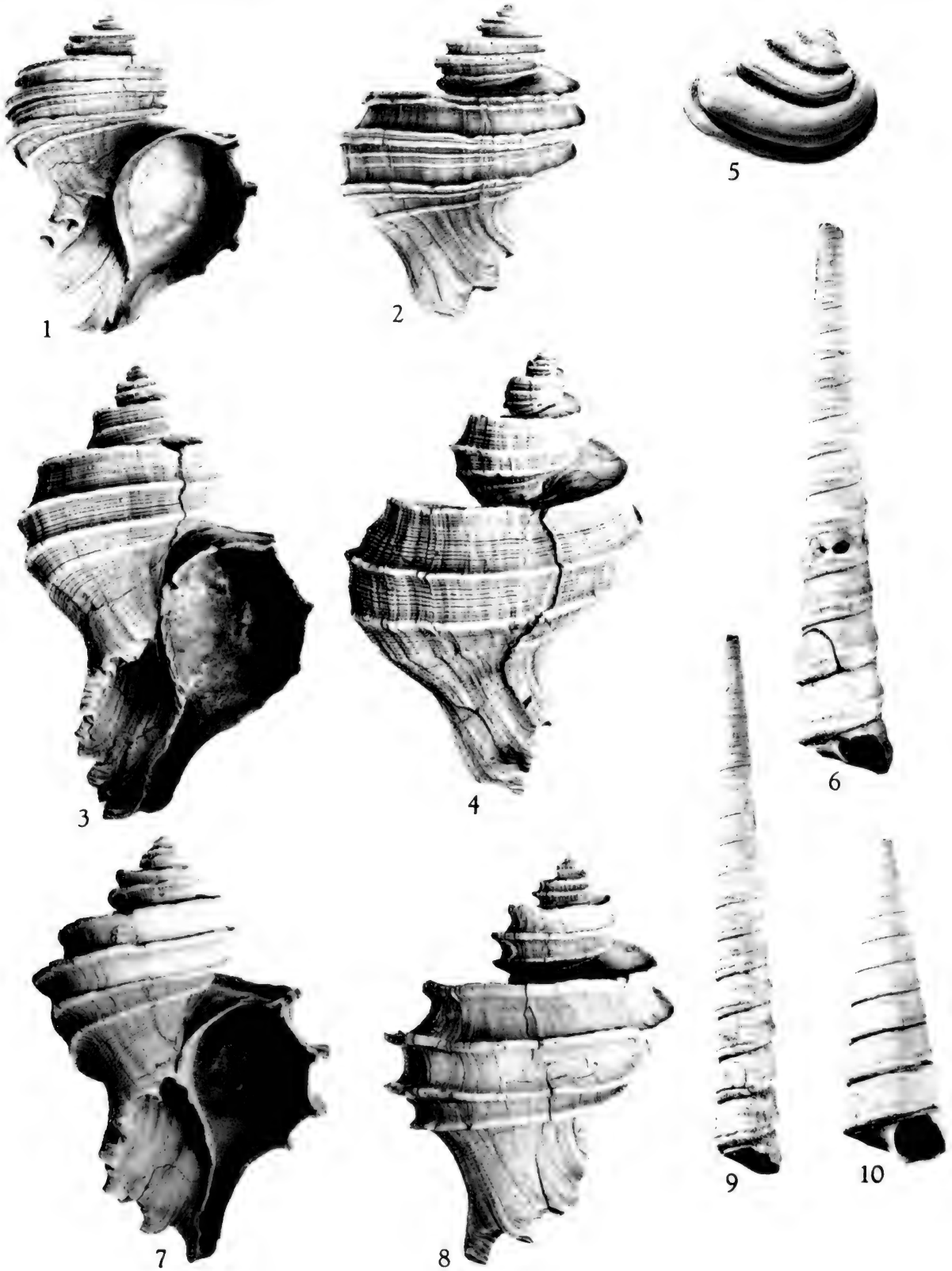
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Plate 24

Mollusks of the *Dimarzipecten crocus/Pecten humphreysii* Interval-zone (M-14)

Figure

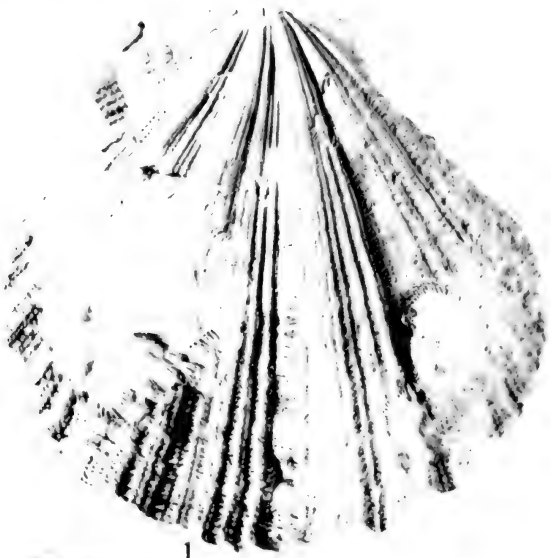
1. *Rebeccapecten berryae* Ward, new species (p. 64)
   Holotype (USNM 405194), left valve; Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); length 73.0 mm, height 75.8 mm.
2. *Dimarzipecten crocus* (Cooke) (p. 68)
   Right valve (USNM 405197); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); length 25.3 mm, height 29.8 mm.

3, 5. *Astarte claytonrayi* Ward, new species (p. 85)
   3. Exterior, left valve, holotype (USNM 405241); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); length 16.1 mm, height 15.9 mm.
   5. Interior, same specimen.

4. *Astarte onslowensis* Kellum (p. 85)
   Right valve, holotype (USNM 353244); Silverdale, Onslow Co., N.C. (USGS loc. 10655); length 11.5 mm, height 11.0 mm.

6-9. *Chama chipolana* Dall (p. 81)
   6. Exterior, left valve (USNM 405228); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); length 34.9 mm, height 36.4 mm.
   7. Interior, same specimen.
   8. Exterior, right valve (USNM 405229); same locality length 26.9 mm, height 24.7 mm.
   9. Interior, same specimen.

10. *Stewartia anodonta* (Say) (p. 79)
   Right valve (USNM 405223); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); length 37.0 mm, height 37.6 mm.
11. *Cunearca silverdalensis* (Kellum) (p. 53)
   Left valve (USNM 353302); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); length 16.0 mm, height 11.0 mm.
12. *Anomia ruffini* Conrad (p. 75)
   Left valve (USNM 405212); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); length 46.9 mm, height 44.4 mm.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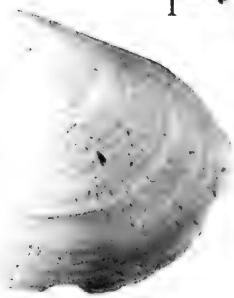
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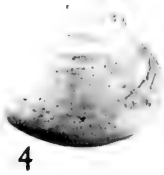
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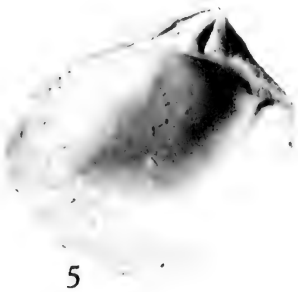
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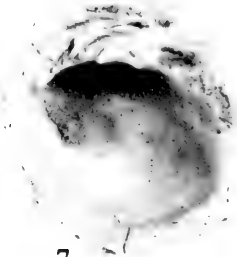
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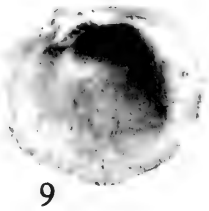
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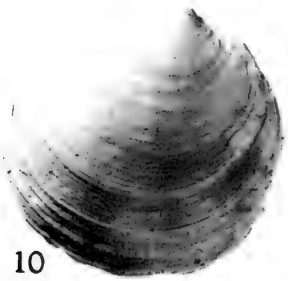
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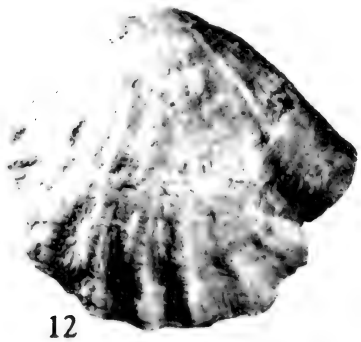
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Plate 25

Mollusks of the *Dimarzipecten crocus/Pecten humphreysii* Interval-zone (M-14)

Figure

1. *Glyptoactis nodifera* (Kellum) (p. 82)
   Right valve (USNM 405235); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); length 22.5 mm, height 25.0 mm.
2. *Cyclocardia trentensis* Ward, new species (p. 81)
   Holotype, left valve (USNM 405230); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); length 16.1 mm, height 14.9 mm.
3. *Dinocardium taphrium* Dall (p. 93)
   Left valve (USNM 405255); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); length 39.0 mm, height 39.0 mm.

4, 6. *Macrocallista acuminata* Dall (p. 100)
   4. Exterior, right valve (USNM 405271); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); length 52.2 mm, height 37.4 mm.
   6. Interior, same specimen.

5. *Mercenaria capax* (Conrad) (p. 110)
   Latex cast, interior, right valve (USNM 366541); Warren Brothers sand pit, Henrico County Va. (loc. 32, USGS loc. 26417); length 44.5 mm, height 38.4 mm.
7. *Chione spada* Dall (p. 104)
   Left valve (USNM 405280); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); length 34.5 mm, height 27.8 mm.
8. *Anomalocardia floridana* Conrad (p. 104)
   Left valve (USNM 405279); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); length 37.2 mm, height 31.4 mm.
9. *Donax idoneus* Conrad (p. 96)
   Neotype, right valve (USNM 405264); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); length 39.9 mm, height 27.4 mm.

10-12. *Mya wilsoni* Ward, new species (p. 111)
   10. Exterior, holotype, left valve (USNM 338603); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); length 27.8 mm, height 20.7 mm.
   11. Interior, same specimen.
   12. View of hinge, same specimen.


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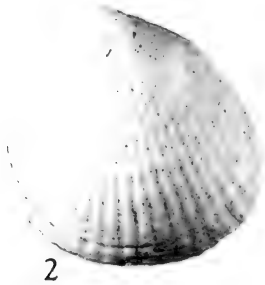
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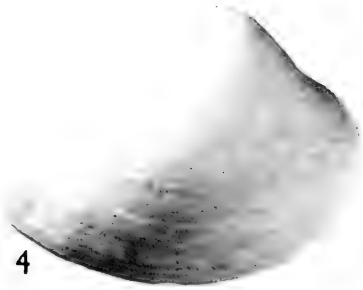
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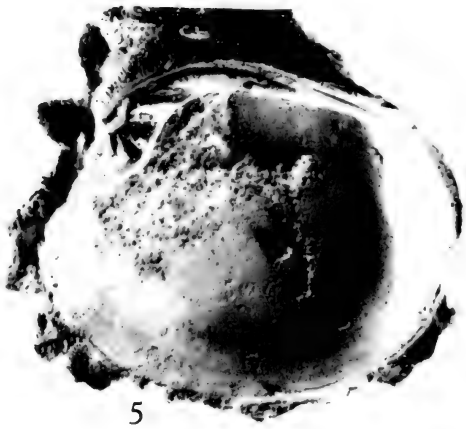
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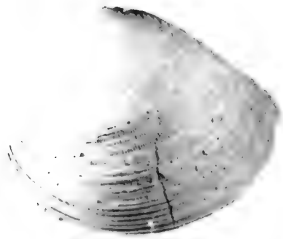
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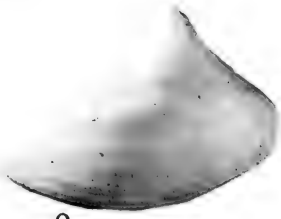
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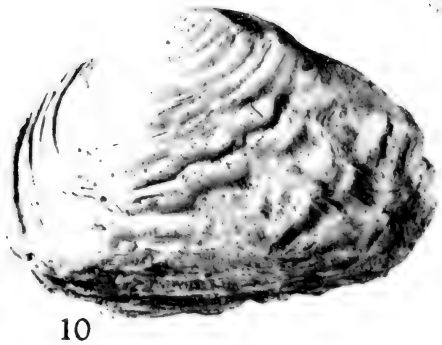
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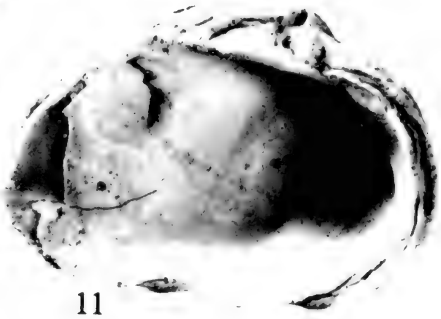
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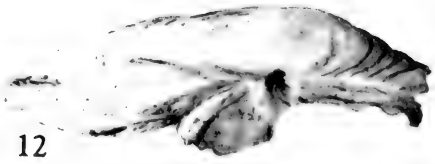
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Plate 26

Mollusks of the *Dimarzipecten crocus/Pecten humphreysii* Interval-zone (M-14)

Figure

1. *Fusinus hoffmani* Ward, new species (p. 134)
   Apertural view, holotype (USNM 405338); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); height 51.7 mm.
2. *Busycon spiniger onslowensis* Kellum (p. 131)
   Apertural view (USNM 405329); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); height 40.3 mm.
3. *Turritella tampae* Heilprin (p. 119)
   Apertural view, incomplete specimen (USNM 405310); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); height 85.7 mm.
4. *Typhis siphonifera* Dall (p. 130)
   Apertural view (USNM 405327); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); height 28.4 mm.
5. *Sinum imperforatum* Dall (p. 120)
   Apertural view (USNM 405312); Silverdale, Onslow Co., N.C. (loc. 30, USGS loc. 26571); height 17.2 mm.

6-9. *Ecphora tampaensis* (Dall) (p. 129)
   6. Apertural view, nearly complete specimen (USNM 405323); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); height 16.2 mm.
   7. Posterior, same specimen.
   8. Apertural view, incomplete specimen (USNM 405324); same locality; height 17.5 mm.
   9. Posterior, juvenile (USNM 405325); same locality; height 13.8 mm.

10. *Tritonopsis biconica* (Dall) (p. 121)
    Apertural view (USNM 405314); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); height 17.9 mm.
11. *Tritonopsis gilletti* (Richards) (p. 120)
    Apertural view (USNM 405313); Belgrade, Onslow Co., N.C. (loc. 29, USGS loc. 26570); height 36.1 mm.


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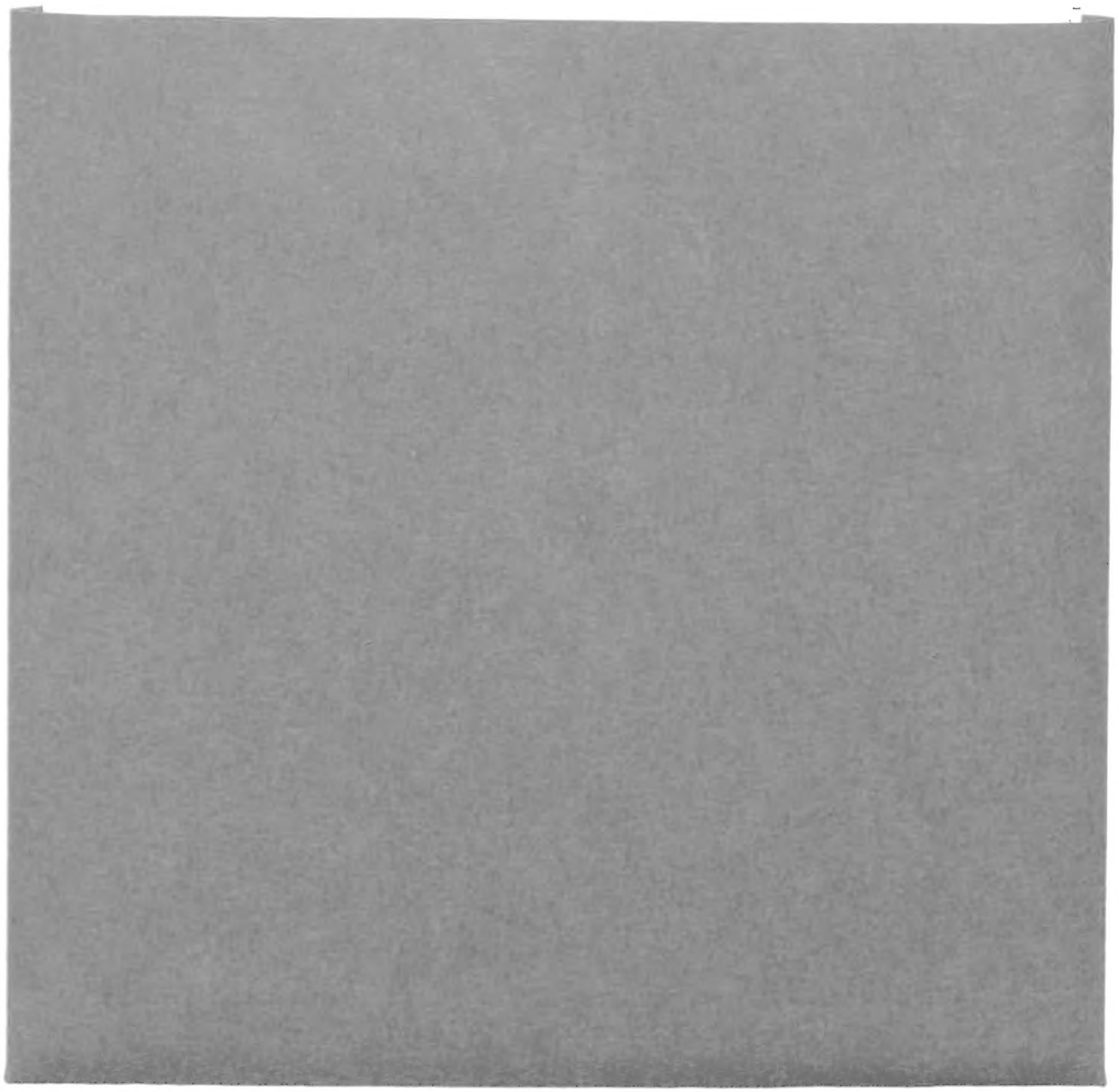
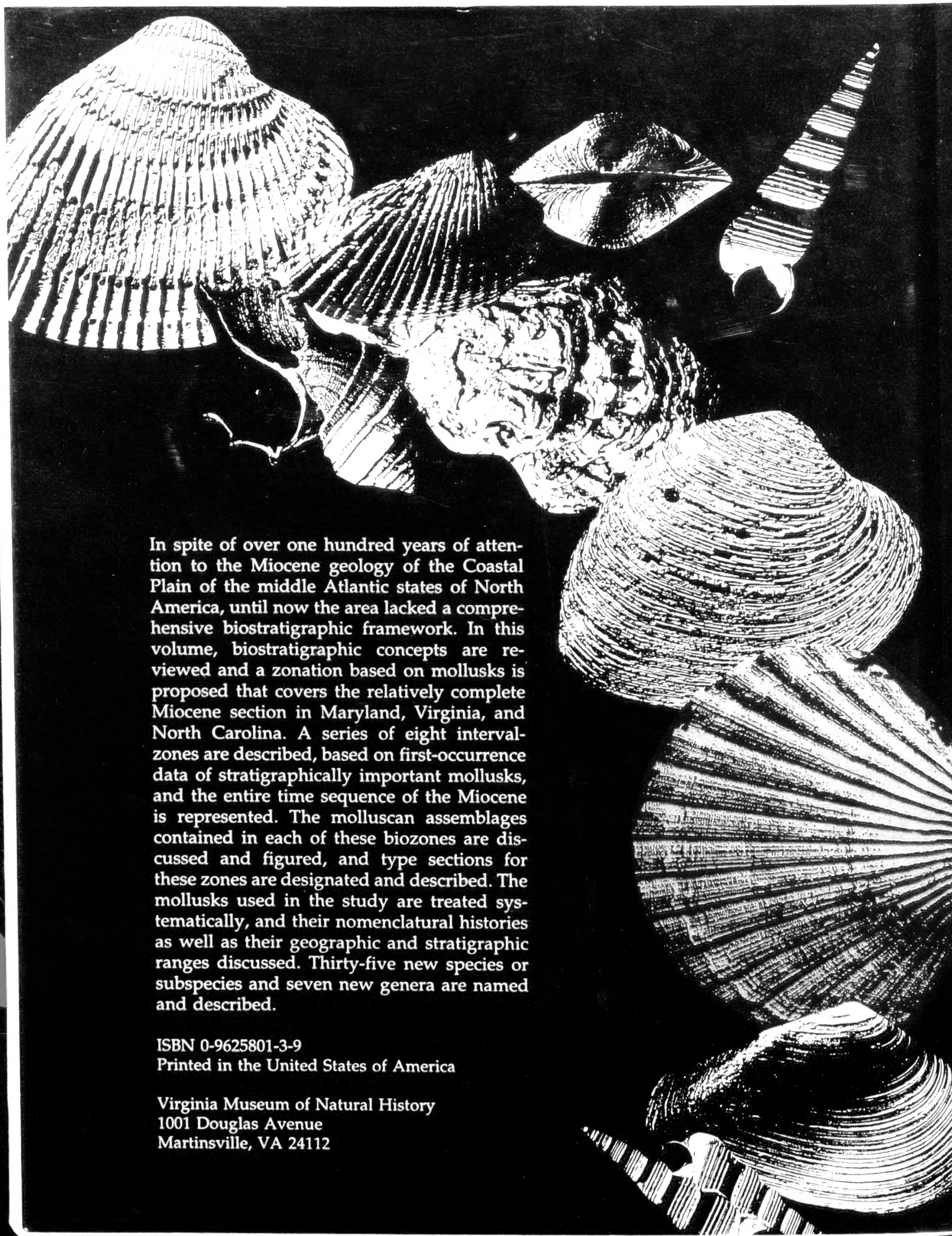
TABLE 1





In spite of over one hundred years of attention to the Miocene geology of the Coastal Plain of the middle Atlantic states of North America, until now the area lacked a comprehensive biostratigraphic framework. In this volume, biostratigraphic concepts are reviewed and a zonation based on mollusks is proposed that covers the relatively complete Miocene section in Maryland, Virginia, and North Carolina. A series of eight interval-zones are described, based on first-occurrence data of stratigraphically important mollusks, and the entire time sequence of the Miocene is represented. The molluscan assemblages contained in each of these biozones are discussed and figured, and type sections for these zones are designated and described. The mollusks used in the study are treated systematically, and their nomenclatural histories as well as their geographic and stratigraphic ranges discussed. Thirty-five new species or subspecies and seven new genera are named and described.

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Virginia Museum of Natural History
1001 Douglas Avenue
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